

## Appendix E – Biological Evaluation




**Biological Evaluation  
of the  
Green Mountain National Forest Land and Resource Management Plan Revision  
on  
Federal Endangered, Threatened, and Proposed Species and Regional Forester  
Sensitive Species**

Addison, Bennington, Rutland, Washington, Windham, and Windsor Counties, Vermont

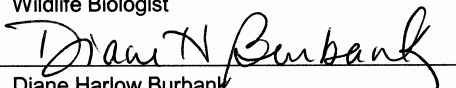
USDA Forest Service  
Green Mountain National Forest  
231 North Main Street  
Rutland, Vermont 05701  
(802) 747-6700

Prepared by:

  
John L. Sease  
Wildlife Biologist

Date:

14 February 2006

  
Diane Harlow Burbank  
Forest Ecologist

Date:

14 February 2006

The United States Department of Agriculture (USDA) prohibits discrimination in all of its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political affiliation, sexual orientation, and marital or familial status (not all prohibited bases apply to all programs). Persons with disabilities who require alternative means of communication or program information (Braille, large print, audiotape, etc.) should contact the USDA's TARGET Center at 202-720-2600 (voice or TDD).

To file a complaint of discrimination, write the USDA, Director, Office of civil Rights, Room 326-W, Whitten Building, 14<sup>th</sup> and Independence Avenue, Washington, DC, or call 202-720-5964 (voice or TDD). The USDA is an equal opportunity provider and employer.

## Table of Contents

<b>Chapter 1 – Purpose and Need .....</b>	<b>4</b>
Introduction .....	4
Proposed Management Action and Alternatives .....	4
Consultation History .....	11
Species Evaluated .....	11
<b>Chapter 2 – Overview of Management Context .....</b>	<b>14</b>
Description of the Planning Area .....	14
Management Direction .....	19
Analysis and Management Process .....	28
<b>Chapter 3 - Analysis of Effects, Federally-listed Species .....</b>	<b>29</b>
Conservation Status Ranks .....	29
Summary of Species Determinations .....	29
Effects Common to All Alternatives .....	30
Gray wolf.....	30
Eastern Cougar.....	32
Canada Lynx.....	34
Indiana Bat.....	36
Bald Eagle.....	46
<b>Chapter 4 – Analysis of Effects, Regional Forester Sensitive Animals .....</b>	<b>50</b>
Summary of Species Determinations .....	50
Effects Common to All Alternatives .....	50
Eastern Small-footed Bat .....	51
Bicknell’s Thrush .....	56
American Peregrine Falcon .....	60
Common Loon.....	63
Wood Turtle .....	66
Jefferson Salamander .....	71
Boulder Beach Tiger Beetle .....	75
Odonates .....	77
Brook Floater.....	81
Creek Heelsplitter .....	83
<b>Chapter 5 – Analysis of Effects, Regional Forester Sensitive Plants .....</b>	<b>85</b>
Introduction .....	85
Summary of Species Determinations .....	87
Effects Common to All Alternatives across Habitats.....	87
Species of Alpine and Subalpine Habitats.....	88
Species of Rock or Cliff Habitat .....	92
Species of Barrens and Open Uplands .....	98
Species of Aquatic Habitats .....	103
Species of Shore Habitat .....	108
Species of Open Wetlands.....	115
Species of Forested Wetlands.....	121
Species of Rich Northern Hardwood Forest .....	128
Species of Dry, Low-elevation Forests and Woodlands.....	135
Species of Conifer Forests .....	144
<b>Literature Cited.....</b>	<b>152</b>

## Chapter 1 – Purpose and Need

### Introduction

This Biological Evaluation (BE) is prepared in accordance with policy provided in Forest Service Manual (FSM) 2672.42 and Section 7 of the Endangered Species Act (ESA). This policy is designed to avoid impacts that may cause a trend toward listing of a species under the Endangered Species Act, or loss of species viability. The purpose of this document is to determine the potential effects of the revised Green Mountain National Forest (GMNF) Land and Resource Management Plan (Forest Plan or Plan), and its alternatives, on federally-listed threatened, endangered, and proposed (TE) species, and Regional Forester sensitive species (RFSS), that may occur within the GMNF. The need for revision of the GMNF Forest Plan stems from regulations under the National Forest Management Act of 1976 (NFMA) that require Forests to evaluate and revise their management plans every 10-15 years; the current GMNF Forest Plan was approved in 1987.

Federally endangered and threatened species are those determined for eligibility based on guidelines listed by the United States Department of Interior Fish and Wildlife Service (USFWS) under Section 4 of the Endangered Species Act. The GMNF consulted with the USFWS to determine which federally-listed species to evaluate in this Biological Evaluation (USFWS 2004, USFWS 2006). Species included on the Regional Forester sensitive species list must occur on Forest Service land or within the proclamation boundary of the Forest, and meet at least one of the following criteria: 1) are a candidate for federal listing under ESA; 2) have been delisted under ESA within the last five years; 3) have a global (G), national (N), or trinomial (T) rank of 1, 2, or 3 from the Association of Biodiversity Information; or 4) are otherwise considered “at risk” on the Forest, with rationale documented in a Risk Evaluation. Development of the most recent RFSS list for the Green Mountain National Forest (USFS 2003) was based on reviews of field data and literature conducted by the Forest Service in cooperation with the Vermont Nongame and Natural Heritage Program, the Vermont Fish and Wildlife Department, local interest groups, and other cooperators.

The Forest Service also conducted a Species Viability Evaluation (SVE) as part of Forest Plan revision. This was a qualitative process to identify and gather information about vertebrate, invertebrate, and plant species of potential viability concern on the Forest, including threatened, endangered, and sensitive species. The evaluation involved compilation of information from scientific literature and consultation with local wildlife and botanical experts, including state agencies, faculty at local universities, and Forest Service researchers. As part of the process, the Forest Service asked local experts to evaluate the current condition of each species and determine the degree to which ecological conditions on the GMNF may contribute to species viability, both currently and over the next 20 years. The evaluation by the panels and information contained in the literature compilations were valuable in helping to analyze the effects of implementing the revised Plan and its alternatives on threatened, endangered, and sensitive species.

### Proposed Management Action and Alternatives

As required by the NFMA, the Green Mountain National Forest proposes to revise the 1987 Forest Plan for all of the resources managed by the Forest. The Code of Federal Regulations (36 CFR 219.10[g]) implementing the NFMA instructs the Regional Forester to make periodic revisions to the Forest Plan. The existing Forest Plan was approved on January 15, 1987, and there have been nine amendments to this Plan.

Federal law, regulations, and policy provide guidance and direction for natural resource management activities on National Forests. Within this context, the Forest Plan does not identify site-specific actions, but provides a framework within which future activities may be implemented. The Forest Plan does this by identifying goals, objectives, standards, guidelines, management areas (MAs), and monitoring requirements for the ten-year planning period, which begins when the Forest Plan is approved. Goals and objectives form the basis for developing and implementing projects to make progress towards the

desired future condition of the land and its resources. Standards and guidelines provide more detailed direction on how project activities may be conducted, and are usually more specific than those found in laws, regulations, and policies. The Forest Plan also allocates land to specific MAs, each with a different resource emphasis and desired future condition, although much overlap can exist.

The revision of the GMNF Forest Plan involved assessments of resource conditions, including review of the most current scientific literature available, and extensive public involvement through public meetings, public forums, and field trips. A goal for Forest Plan revision was to develop one set of Forest Plan goals, objectives, standards, guidelines, management areas, and monitoring requirements that were consistent with laws, regulations, and policies, while meeting public needs and desires and local resource conditions on the Forest. These aspects of management direction for the revised Forest Plan are discussed in detail in Chapter 2.

Another goal of Plan revision was development of alternative approaches to allocating the lands within the Forest to each of the different management areas, in order to provide a range of options for meeting public interests and resource needs. These alternatives are based on issues raised by the public and the Forest Service. During the revision process, concern arose from the public and the Forest Service relative to five primary issues; these were noted in the Forest Service's Notice of Intent to revise the Forest Plan (USDA 2001). These issues, which are presented in detail in Chapter 1 of the Draft Environmental Impact Statement (DEIS), are summarized as follows:

1. **Special designations:** develop an appropriate mix of specially designated areas (such as Wilderness, Wild and Scenic Rivers, National Recreation Areas, and Research Natural Areas, among others) to promote ecological, social, and economic sustainability
2. **Biodiversity and ecosystem management:** provide appropriate quantity, quality, distribution, and diversity of habitats for wildlife and threatened, endangered, and sensitive species, as well as threats to these species (for example, invasive exotic species)
3. **Social and economic concerns:** recognize community concerns and opportunities, address potential economic impacts and benefits, consider the changing demographics in rural communities, and provide multiple use management for the GMNF
4. **Recreation management:** provide an appropriate mix of recreation opportunities, including primitive, backcountry, and low-density recreation, more developed, higher-density recreation, as well as motorized and un-motorized trail use
5. **Timber management:** determine the appropriate level for timber harvesting to maintain and enhance diversity of vegetation, wildlife habitats, vistas, health and condition of the forest ecosystem, and to produce high quality sawtimber, including establishing methods and uses for vegetation management, the desired mix and location of age distribution and species composition of vegetation, and the identification of lands where natural processes will determine the composition and structure of the forest

Based on these issues, the Forest Service developed five alternatives for the revised Forest Plan. These alternatives are described in detail in Chapter 2 of the DEIS and summarized as follows:

**Alternative A – No Action Alternative:**

Alternative A is the "Current Management," or the "No Action" alternative. The Forest Service is legally required to analyze this alternative, which provides a baseline for the comparison of the other alternatives. The Forest Service acquired over 90,000 acres during the current Forest Plan, allocating these lands to MA 9.2 (Newly Acquired Land). This Management Area (MA) keeps Newly Acquired Land in a holding status, protecting natural resources and allowing no management actions that might compromise or limit future management opportunities until completion of analyses and evaluations to determine appropriate and desirable management for each parcel. Alternative A maintains Significant Streams and does not use the information on Wild, Scenic and Recreational Rivers (WSR) provided by the study completed for Plan Revision. Alternative A includes updated Plan sections, such as MA descriptions, standards, guidelines, goals, objectives, and indicators. Alternative A does not include any

newly-created MAs (Remote Wildlife Habitat, Green Mountain Escarpment, Alpine/Subalpine Special Area, Moosalamoo Recreational and Educational Area).

#### Special Designations

- WILDERNESS – Alternative A does not provide any Wilderness Study Area MA (areas recommended additional Wilderness Management Areas), nor does it increase any of the existing Wilderness MA boundaries by adding small, adjoining parcels.
- WILD & SCENIC RIVERS – Alternative A will maintain the Significant Streams Management Area with 11 Eligible Rivers and 38 Significant Streams. The Forest Service completed a study of potentially eligible Wild, Scenic, and Recreational Rivers during Plan revision and identified twenty rivers to be eligible (USDA 2004). Of these 20 rivers, only the rivers already included in the Significant Streams MA will be managed as such in Alternative A.
- SPECIAL AREAS - Alternative A maintains the existing level of Special Area MAs and does not add any new Special Areas. Boundaries of Special Areas are adjusted in order to correct mapping areas in the current plan.
- NATIONAL RECREATION AREA – Alternative A does not propose any increase in National Recreation Area.

#### Biodiversity & Ecosystem Management

Biodiversity and ecosystem management concerns are addressed through goals, objectives, standards and guidelines. Over 90,000 acres of newly acquired lands (MA 9.2) are not assigned to management areas and the FS will not be able to manage to improve biodiversity and ecosystems on these lands in Alternative A. The Diverse Forest Use and Diverse Backcountry MA directions will improve biodiversity and ecosystem management in Alternative A by allowing greater flexibility in vegetation treatments on a substantial number of acres.

#### Social & Economic Concerns

Alternative A provides the same social and economic opportunities currently provided on the GMNF. These opportunities include a mix of recreational opportunities, tourism, timber production, and other economic benefits.

#### Recreation Management

Under Alternative A, recreational opportunities and management would remain very much as they presently are in the 1987 Plan. Trails and roads located in over 90,000 acres of newly acquired lands (9.2) that are not on the FS system would continue to receive only minimal or no maintenance.

#### Timber Management

Under Alternative A, timber management opportunities would be slightly improved from the Current Plan. The change to a Diverse Forest Use and Diverse Backcountry Management Areas will improve timber management by allowing greater flexibility for using the best vegetation management practices in the most appropriate locations. Over 90,000 acres of newly acquired lands (MA 9.2) would not be assigned to a new MA in Alternative A. Many of these lands are tentatively suitable for timber harvesting but in this alternative they remain in MA 9.2, which does not allow timber harvesting.

#### **Alternative B**

The driving forces behind the development of Alternative B are a desire for increased active timber and wildlife habitat management, a desire to accommodate a wide range of uses and a desire to improve ecosystem management and biodiversity. This alternative emphasizes flexibility in application of timber management to develop a wide range of economic, recreation, and habitat maintenance opportunities, including production of high-quality saw timber. This alternative also emphasizes increasing the availability of early successional growth to provide habitat for wildlife species that depend on it.

### Special Designations

- WILDERNESS – Alternative B provides for small additions to existing Wilderness MAs. The focus of these additions is to improve the boundary management of the areas. New Wilderness MAs are not proposed in Alternative B.
- WILD & SCENIC RIVERS – The Forest Service determined that twenty rivers are eligible, but none has been analyzed for suitability. These 20 rivers will be managed as Eligible Wild and Scenic Rivers MAs in Alternative B.
- SPECIAL AREAS – The same Special Area MA corrections were made in Alternative B as were in Alternative A. Two areas of the Green Mountain Escarpment land type association have been proposed as Special Area MAs. These areas of the Escarpment contain rare natural communities. The Mt. Abraham Special Area MA has been expanded to include the Lincoln Peak Alpine/Subalpine area to provide for biodiversity on the GMNF – only 2 areas of the GMNF have alpine/subalpine communities. The Mount Horrid Special Area MA is also expanded. Alternative B adds Special Areas MAs in the newly acquired lands as well as a number of other Special Area MAs to provide additional protection for ecologically important resources.
- NATIONAL RECREATION AREA – Alternative B does not propose any increase in National Recreation Area.

### Biodiversity & Ecosystem Management

Alternative B emphasizes more active management in providing biodiversity. The increased amount of Diverse Forest Use provides for flexibility to provide management that is appropriate to the conditions on the ground. Wilderness and additional proposed Remote Backcountry areas provide areas where vegetation management will not occur, allowing for potential old growth. Alternative B allocates a few remote areas to the new Remote Wildlife Habitat MA, which allows timber and vegetation management and emphasizes creation and maintenance of wildlife habitat while retaining the remote qualities of the areas. Many rare natural communities are protected in Special Areas.

### Social & Economic Concerns

Alternative B provides opportunities to maintain the working landscape of Vermont as well as many recreational opportunities. This alternative benefits businesses and communities dependent on timber harvesting and related manufacturing and service jobs. It will also benefit the tourism and recreation related sectors that are focused on a more developed, active recreation environment.

### Recreation Management

A higher level of recreation that requires road access is provided in this alternative. Much of the GMNF is in the Diverse Forest Use management area that allows for developed recreation, roads, and motorized trails. There are also a number of areas that provide backcountry motorized opportunities. Areas that provide less accessible, remote, non-motorized opportunities are more limited in Alternative B.

### Timber Management

This alternative provides the greatest opportunities and flexibility for timber management. A large majority of the Forest is in management areas that allow for commercial timber harvesting and vegetation management for ecosystem and wildlife benefits. The Diverse Forest Use MA provides for flexibility in the type of management dependent on the desired vegetation composition. Most of the newly acquired (9.2) areas were allocated to MAs that allow harvesting. The Green Mountain Escarpment Special Area MA provides opportunities to manage vegetation specifically to maintain ecosystems that require disturbance such as oak and pine. There has been a small increase in the Wilderness and Remote Backcountry MAs that do not allow timber management.

### Alternative C

The driving forces for the development of Alternative C are the desire for a wide range of recreational experiences, more areas with mature forest, improved ecosystem management and biodiversity, and a desire to improve tourism opportunities. Alternative C places an emphasis on a variety of more remote recreational opportunities and longer rotation periods for timber harvesting.

Special Designations:

- WILDERNESS – Alternative C proposes additions to existing Wilderness MAs to improve boundary management. Alternative C also proposes two new Wilderness Study MAs, one in Glastenbury on the west side of the Appalachian Trail corridor and the other along the high peaks of Worth Mountain, Monastery Mountain, and Philadelphia Peak.
- WILD & SCENIC RIVERS – The Forest Service determined that twenty rivers are eligible but none has been analyzed for suitability. These 20 rivers will be managed as Eligible Wild and Scenic Rivers MAs in Alternative C.
- SPECIAL AREAS – The same Special Area MA corrections that were made in Alternative A have been made in Alternative C. The new Special Areas that were added in Alternative B are also added in Alternative C unless they are in a protective management area such as Remote Backcountry MA.
- NATIONAL RECREATION AREA – Alternative C does not propose any increase in National Recreation Area.
- MOOSALAMOO RECREATION AND EDUCATION AREA – Alternative C proposes a new management area, Moosalamoo Recreation and Education Area. This management area addresses the interest in recreational diversity, ecological and heritage education, and tourism in the area.

Biodiversity & Ecosystem Management

Alternative C contains more management areas, such as Remote Backcountry or Wilderness, that do not allow for timber management. It also contains larger areas that will be managed for longer rotations and more mature forests. This will decrease the amount of early successional growth and increase mature and old forest areas. Alternative C allocates a number of areas to the new Remote Wildlife Habitat MA, which allows timber and vegetation management and emphasizes creation and maintenance of wildlife habitat, while retaining the remote qualities of the areas. Many rare natural communities are protected in Special Areas.

Social & Economic Concerns

Recreational opportunities that occur on the GMNF are maintained or enhanced in Alternative C. This will benefit many of the tourism and recreation-oriented businesses in the area. It also provides for many of the recreational and cultural benefits that area communities rely on receiving from the GMNF, particularly through the White Rocks NRA and the Moosalamoo Recreation and Education Area. This Alternative also benefits timber based economics and maintenance of a working landscape.

Recreation Management

A balanced diversity of recreational opportunities is provided through Alternative C. Areas that provide road access will remain the same but areas without roads are predominantly placed in backcountry or remote management areas. This will provide greater opportunities for non-motorized recreational activities. Remote motorized recreational opportunities are also emphasized in Alternative C. Additional Wilderness will provide increased opportunities for solitude and challenge on the GMNF.

Timber Management

Alternative C provides for more areas with longer rotation periods providing more areas of mature forest. It also has many areas with restricted or no timber harvesting providing future old growth areas. Approximately thirty percent of the Forest is allocated to the Diverse Forest Use MA meaning fewer areas will provide for flexible timber management. The Moosalamoo Recreation and Education Area also provides opportunities for flexible timber management as well as an emphasis on forestry demonstration areas. The Green Mountain Escarpment Special Area MA provides opportunities to manage vegetation specifically to maintain ecosystems that require disturbance such as oak and pine. Alternative C provides for areas that allow timber management, which will benefit wildlife habitat, while retaining the remote qualities of the areas.



**Alternative D**

The driving forces for the development of Alternative D are the desire to improve ecosystem management and biodiversity, to increase mature/old forest, to have representatives of most natural communities in areas with minimal management, and to restore and protect rare and uncommon ecosystems while providing for a range of other uses. Alternative also emphasizes management to improve wildlife habitat in areas that will retain their remote qualities.

**Special Designations:**

- **WILDERNESS** – Alternative D provides for the same small additions to existing Wilderness MAs that are in Alternative C. Two new Wilderness Study MAs are proposed in this alternative, Glastenbury and Monastery Mountain. The Glastenbury area includes much of the Glastenbury Inventoried Roadless Area south of the MacIntyre Trail. The proposed Wilderness in the Monastery Mountain area includes most of the Worth Mountain Inventoried Roadless Area. These areas would provide significant increases to the GMNF's Wilderness MAs.
- **WILD & SCENIC RIVERS** – The Forest Service determined that twenty rivers are eligible but none has been analyzed for suitability. These 20 rivers will be managed as Eligible Wild and Scenic Rivers MAs in Alternative D.
- **SPECIAL AREAS** – Boundary inaccuracies have been corrected and the Special Areas that were added in Alternative C are also added in Alternative D. In this alternative the majority of the Green Mountain Escarpment is included as a Special Area. This provides the greatest capacity for restoration and maintenance of the Escarpment's natural communities. The areas of the Escarpment that are not Special Areas are included in Wilderness. Some Special Areas are expanded or connected to enhance the ecosystems. Alternative D does not allocate lands to the Moosalamoo Recreation and Education Area.
- **NATIONAL RECREATION AREA** – Alternative D does not propose any increase in National Recreation Area

**Biodiversity & Ecosystem Management**

Alternative D provides the greatest acreage in management areas that do not allow for timber management, and the largest amount in management areas where longer rotations and mature forest are emphasized. This alternative also provides these areas in large blocks of contiguous habitat. Areas surrounding these large blocks of contiguous habitat would have more active management and habitat creation, and provide connections to important areas. Alternative D emphasizes habitat restoration. To the extent possible, representatives of most natural communities are included in Wilderness, Wilderness Study Areas, White Rocks NRA, Remote Backcountry, and Special Area MAs. Alternative D allocates a number of areas to the new Remote Wildlife Habitat MA, which allows timber and vegetation and emphasizes creation and maintenance of wildlife habitat while retaining the areas' remote qualities. Additional Wilderness provides areas without vegetation or habitat management.

**Social & Economic Concerns**

This alternative is not directly designed to address social and economic concerns. Maintenance of biodiversity and natural communities is considered important by most area communities and can enhance tourism. Nature- and wildlife-oriented businesses may benefit from Alternative D. Timber-related economic aspects would benefit less but would still benefit through the restoration and maintenance of some habitats and natural communities.

**Recreation Management**

Recreation opportunities provided in this alternative lean toward the more remote non-motorized type of activities. Improvements in habitat and biodiversity should increase opportunities for nature and wildlife oriented activities such as photography, viewing, and hunting. The proposed increase in remote areas and wilderness also provides greater opportunities for solitude and challenge. Alternative D provides greater opportunities for these types of activities than any of the other alternatives; it provides less opportunity for motorized recreational activities than the other alternatives.

### Timber Management

Timber management in Alternative D would primarily be focused on ecosystem and habitat maintenance and restoration. The Green Mountain Escarpment Special Area MA is largest in this alternative, maximizing opportunities to manage vegetation specifically to maintain ecosystems that require disturbance methods including timber harvesting. This alternative contains less Diverse Forest Use than the other alternatives, and therefore, provides less area with flexible timber management. The highest level of areas that do not allow timber harvesting is found in Alternative D.

### Alternative E

The driving forces for the development of Alternative E are the desire to provide a range of uses, the desire to improve ecosystem management and biodiversity, the desire to provide a range of timber management areas and the desire to provide a diverse range of recreational opportunities. Alternative E emphasizes a mix of opportunities in recreation, timber management, wildlife habitat management, and ecosystem management.

### Special Designations:

- **WILDERNESS** – Alternative E provides for the same small additions to existing Wilderness MAs that are in Alternative C and D. It proposes Glastenbury Mountain as a Wilderness Study Area, with a configuration similar to Alternative C but expanded east of the Appalachian Trail.
- **WILD & SCENIC RIVERS** – The Forest Service determined that twenty rivers are eligible but none has been analyzed for suitability. These 20 rivers will be managed as Eligible Wild and Scenic Rivers MAs in all alternatives.
- **SPECIAL AREAS** – Boundary inaccuracies have been corrected and the Special Areas that were added in Alternative C and D are also added in Alternative E. Grout Pond Ecological Special Area has been enlarged, and additional old forest habitat has been added to the French Hollow Ecological Special Area. Much, but not all, of the Green Mountain Escarpment is included as a Special Area. This provides some capacity for restoration and maintenance of the Escarpment's natural communities. Other special areas are expanded or connected to enhance the ecosystems.
- **NATIONAL RECREATION AREA** – Alternative E does not propose any increase in National Recreation Area.
- **MOOSALAMOO RECREATION AND EDUCATION AREA** – Alternative E proposes a new management area, Moosalamoo Recreation and Education Area, similar to that found in Alternative C. This management area addresses the interest in recreational diversity ecological and heritage education, and tourism in the area.

### Biodiversity & Ecosystem Management

Alternative E provides for large contiguous blocks of land with habitat restoration and recreation activities. This alternative allocates a number of large, remote areas to the new Remote Wildlife Habitat MA, which allows timber and vegetation management and emphasizes creation and maintenance of wildlife habitat, while retaining the remote qualities of the areas. More accessible areas are managed to provide early successional habitats. Representatives of many natural communities are included in Wilderness, Wilderness Study Areas, White Rocks NRA, Remote Backcountry, Remote Wildlife Habitat, and Special Area MAs. Additional wilderness provides areas without vegetation or habitat management.

### Social & Economic Concerns

This alternative provides a range of opportunities to address social and economic concerns. It provides areas for timber harvesting and high quality sawtimber. Alternative E also provides a range of recreational opportunities from motorized/developed recreation to non-motorized/remote recreation. It also provides many of the recreational and cultural benefits that area communities rely on receiving from the GMNF, particularly through the White Rocks NRA and the Moosalamoo Recreation and Education Area. Areas are provided to maintain natural communities and biodiversity which is considered important by most area communities and can enhance tourism.

### Recreation Management

Alternative E provides relatively balanced mix of recreational opportunities and settings. It provides opportunities for remote types of recreation – motorized and non-motorized. Additional proposed Wilderness provides opportunities for solitude but not as great an amount as in Alternative D. Alternative E provides moderate opportunities for motorized/developed recreation in accessible areas.

### Timber Management

Alternative E provides a range of opportunities for timber management. This alternative allocates less acreage to the flexible timber management of the Diverse Forest Use MA than Alternatives A and B, and a similar acreage as in Alternative C, but the acreage allocated to this MA under Alternative E is located in the most accessible areas and includes the most productive areas, thus providing for efficient and productive harvesting. Alternative E allocates more acreage to the Green Mountain Escarpment Special Area MA than in alternatives A, B or C (and slightly less than in Alternative D), increasing opportunities to manage vegetation specifically to maintain ecosystems that require disturbance methods, including timber harvesting. There are more areas focused on wildlife habitat creation, maintenance of natural communities, and longer rotations. These areas are located in less accessible parts of the GMNF.

### Selected Alternative

Alternative E is the Selected Alternative for revising the GMNF Forest Plan. This alternative is described in detail in Section 2.1.4 of the FEIS and is summarized above. It includes the elements common to all alternatives described in Section 2.1.3 of the FEIS, which are summarized below in Chapter 2 of the BE, the management direction, land allocation descriptions, standards and guidelines for management practices, and monitoring and evaluation plan of the Revised Forest Plan, and incorporates comments and concerns expressed by the public.

## **Consultation History**

The Forest Service consulted with the USFWS during 1999 through 2001, regarding potential impacts of management activities under the 1987 Forest Plan on the Indiana bat and other threatened or endangered species. In particular, this consultation responded to new information about the possible presence of Indiana bats on or near the GMNF. In February 2000, the USFWS (USFWS 2000a,b) concluded that continued implementation of the 1987 Plan was not likely to adversely affect the Indiana bat and should have no effect on the bald eagle, eastern cougar, gray wolf, and Canada lynx. The USFWS issued a set of conservation measures for Indiana bat, which were incorporated into the Forest Plan by amendment in April 2002 (USDA 2002b).

Informal consultation with the USFWS began in August 2004, with the Forest Service request for an updated list of endangered, threatened, and proposed species, as well as critical or proposed critical habitat that need to be considered during the revision of the 1987 Plan (USDA 2004). USFWS replied with that list in September 2004 (USFWS 2004). This list is being used in the Forest Service's ongoing evaluation of the Forest Plan revision process. Additional informal consultation has occurred during 2005 including review of the draft Biological Evaluation and DEIS.

## **Species Evaluated**

Tables 1-1 and 1-2 list the 18 animals and 65 plants identified as threatened and endangered (TE) species, or Regional Forester sensitive species (RFSS) to be evaluated in this Biological Evaluation. Because the revised Forest Plan and the Final EIS are programmatic documents based on proposed management direction across the entire GMNF, all species listed as threatened or endangered, or proposed for listing as threatened or endangered under the ESA, or listed as RFSS for the GMNF are included in this evaluation. These lists are based on consultation with the USFWS (2004, 2006) and on the Regional Forester sensitive species list as updated in 2003 (USFS 2003). No species currently proposed for listing under the ESA occur on the GMNF, and the GMNF includes no critical habitat for any listed species (USFWS 2004, USFWS 2006).

**Table 1-1: Endangered, threatened, and sensitive animal species that may occur on the Green Mountain National Forest.**

Common Name	Scientific Name	U.S. status <sup>1</sup>	VT status <sup>2</sup>
<b>MAMMALS</b>			
Gray wolf	<i>Canis lupus</i>	E	
Eastern cougar	<i>Puma (=Felis) concolor cougar</i>	E	E
Canada lynx	<i>Lynx canadensis</i>	T	E
Indiana bat	<i>Myotis sodalis</i>	E	E
Eastern small-footed bat	<i>Myotis leibii</i>	S	T
<b>BIRDS</b>			
Bald eagle	<i>Haliaeetus leucocephalus</i>	T	E
Bicknell's thrush	<i>Catharus bicknelli</i>	S	SC
American peregrine falcon	<i>Falco peregrinus anatum</i>	S	E
Common loon	<i>Gavia immer</i>	S	E
<b>REPTILES</b>			
Wood turtle	<i>Glyptemys (=Clemmys) insculpta</i>	S	SC
<b>AMPHIBIANS</b>			
Jefferson salamander	<i>Ambystoma jeffersonianum</i>	S	SC
<b>INSECTS</b>			
Boulder beech tiger beetle	<i>Cicindela ancocisconensis</i>	S	
Southern pygmy clubtail	<i>Lanthus vernalis</i>	S	
Forcipate emerald	<i>Somatochlora forcipata</i>	S	
Harpoon clubtail	<i>Gomphus (=Phanogomphus) descriptus</i>	S	
Gray petaltail	<i>Tachopteryx thoreyi</i>	S	
<b>MOLLUSKS</b>			
Brook floater	<i>Alasmidonta varicosa</i>	S	T
Creek heelsplitter	<i>Lasmigona compressa</i>	S	
<sup>1</sup> Listed by the USFWS under the federal Endangered Species Act: E is Endangered; T is Threatened; S means listed by the Regional Forester of Region 9 as sensitive for the GMNF. <sup>2</sup> Listed by the State of Vermont under their Endangered Species Statute (10 V.S.A. Chapter 123): E is Endangered; T is Threatened; SC signifies species of Special Concern; a blank means the species is not listed by the State.			

**Table 1-2: Endangered, threatened, and sensitive plant species that may occur on the Green Mountain National Forest.**

Common Name	Scientific Name	U.S. status <sup>1</sup>	VT status <sup>2</sup>
Boreal bentgrass	<i>Agrostis mertensii</i>	S	
Feverweed	<i>Aureolaria pedicularia</i> var. <i>pedicularia</i>	S	
Hairy woodmint	<i>Blephilia hirsuta</i>	S	T
New England northern reed grass	<i>Calamagrostis stricta</i> ssp. <i>inexpansa</i>	S	E
Small-flowered bitter cress	<i>Cardamine parviflora</i> var. <i>arenicola</i>	S	
Summer sedge	<i>Carex aestivalis</i>	S	
Water sedge	<i>Carex aquatilis</i> var. <i>substricta</i>	S	
Hay sedge	<i>Carex argyrantha</i>	S	
Prickly bog sedge	<i>Carex atlantica</i>	S	
Bigelow's sedge	<i>Carex bigelowii</i> ssp. <i>bigelowii</i>	S	
Bronze sedge	<i>Carex foenea</i>	S	E
Shore sedge	<i>Carex lenticularis</i> var. <i>lenticularis</i>	S	
Michaux's sedge	<i>Carex michauxiana</i>	S	
Schweinitz's sedge	<i>Carex schweinitzii</i>	S	
Bulrush sedge	<i>Carex scirpoidea</i>	S	
Purple clematis	<i>Clematis occidentalis</i> var. <i>occidentalis</i>	S	
Horse-balm	<i>Collinsonia canadensis</i>	S	
Squaw-root	<i>Conopholis americana</i>	S	
Fragile rockbrake	<i>Cryptogramma stelleri</i>	S	

**Table 1-2: Endangered, threatened, and sensitive plant species that may occur on the Green Mountain National Forest.**

Common Name	Scientific Name	U.S. status <sup>1</sup>	VT status <sup>2</sup>
Large yellow ladyslipper	<i>Cypripedium parviflorum</i> var. <i>pubescens</i>	S	
Showy ladyslipper	<i>Cypripedium reginae</i>	S	
Paniculate tick-trefoil	<i>Desmodium paniculatum</i>	S	
Rock whitlow-grass	<i>Draba arabisans</i>	S	
Male fern	<i>Dryopteris filix-mas</i>	S	T
Matted spike-rush	<i>Eleocharis intermedia</i>	S	
Sweet joe-pye weed	<i>Eupatorium purpureum</i>	S	
Boreal bedstraw	<i>Galium kamschaticum</i>	S	
Rough avens	<i>Geum laciniatum</i>	S	
Appalachian fir-clubmoss	<i>Huperzia appalachiana</i>	S	
Tuckerman's quillwort	<i>Isoetes tuckermanii</i>	S	
Large whorled pogonia	<i>Isotria verticillata</i>	S	T
Butternut	<i>Juglans cinerea</i>	S	
Highland rush	<i>Juncus trifidus</i>	S	
Hairy bush-clover	<i>Lespedeza hirta</i>	S	T
One flowered muhly	<i>Muhlenbergia uniflora</i>	S	
Farwell's water-milfoil	<i>Myriophyllum farwellii</i>	S	
Low water-milfoil	<i>Myriophyllum humile</i>	S	
Three-leaved rattlesnake-root	<i>Nabalus trifoliolatus</i> (= <i>Prenanthes trifoliolata</i> )	S	
American ginseng	<i>Panax quinquefolius</i>	S	
Green arrow arum	<i>Peltandra virginica</i>	S	
Broad beech fern	<i>Phegopteris hexagonoptera</i>	S	
Pitch pine	<i>Pinus rigida</i>	S	
American shore-grass	<i>Plantago</i> (= <i>Littorella</i> ) <i>americana</i>	S	
Large roundleaf orchid	<i>Platanthera orbiculata</i>	S	
Jacob's ladder	<i>Polemonium vanbruntiae</i>	S	T
Snail-seed pondweed	<i>Potamogeton bicupulatus</i>	S	
Algae-like pondweed	<i>Potamogeton confervoides</i>	S	
Hill's pondweed	<i>Potamogeton hillii</i>	S	
Green pyrola	<i>Pyrola chlorantha</i>	S	
Roseroot stonecrop	<i>Rhodiola</i> (= <i>Sedum</i> ) <i>rosea</i>	S	T
Wild red currant	<i>Ribes triste</i>	S	
White Mountain saxifrage	<i>Saxifraga paniculata</i> ssp. <i>neogaea</i>	S	
Pod grass	<i>Scheuchzeria palustris</i> (=ssp. <i>americana</i> )	S	T
Rock spike-moss	<i>Selaginella rupestris</i>	S	
Pointed blue-eyed grass	<i>Sisyrinchium angustifolium</i>	S	
Eastern blue-eyed grass	<i>Sisyrinchium atlanticum</i>	S	
Squarrose goldenrod	<i>Solidago squarrosa</i>	S	
Northern mountain-ash	<i>Sorbus decora</i>	S	
Floating bur-reed	<i>Sparganium fluctuans</i>	S	
Fernald's manna-grass	<i>Torreyochloa pallida</i> var. <i>fernaldii</i>	S	
Hidden-fruited bladderwort	<i>Utricularia geminiscapa</i>	S	
Northeastern bladderwort	<i>Utricularia resupinata</i>	S	T
Perfoliate bellwort	<i>Uvularia perfoliata</i>	S	
Alpine bilberry	<i>Vaccinium uliginosum</i>	S	
Smooth woodsia	<i>Woodsia glabella</i>	S	

<sup>1</sup> S means listed by the Regional Forester of Region 9 as sensitive for the GMNF.

<sup>2</sup> Listed by the State of Vermont under their Endangered Species Statute (10 V.S.A. Chapter 123): E is Endangered; T is Threatened; a blank means the species is not listed by the State; VNNHP 2002.

## Chapter 2 – Overview of Management Context

This chapter provides a description of the planning area in which threatened and endangered (TE) species and Regional Forester sensitive species (RFSS) occur, and provides an overview of the management direction provided by the revised Forest Plan. TE species and RFSS collectively are called TES species. This management direction consists of goals and objectives for management of the GMNF, and standards and guidelines that govern how management activities are conducted. Direction is also provided for management areas, and includes the emphasis and desired future conditions of the lands within that management area, and more specific standards and guidelines for management activities. This direction is the same across all alternatives; the variation in alternatives is based on how the management areas are distributed across the GMNF. The effects of those variations are discussed below in the analysis of effects of Chapter 3, 4, and 5. In addition to management plan direction, there is abundant direction in Forest Service manuals and handbooks that guides how the agency protects TES species as projects are developed and implemented; this direction is also summarized in Chapter 2.

### Description of the Planning Area

The GMNF encompasses approximately 400,692 acres within the Green and Taconic Mountains of Vermont, and includes portions of Addison, Bennington, Rutland, Washington, Windham, and Windsor Counties. Chapters 1, 2, and the Affected Environment Section in Chapter 3 of the GMNF Plan Revision Final Environmental Impact Statement (Forest Plan FEIS) contain a description of the physical, biological, social, and economic environment. A summary is provided below.

#### Landscape Characterization

In a global context, the Green Mountains sit within the temperate deciduous forest biome (global ecological communities), which covers much of eastern North America, Western Europe, and eastern Asia. The National Hierarchical Framework of Ecosystem Units (Cleland et al. 1997) classifies and maps ecological units based on associations of different factors. These factors include climate, topography, soils, water, and potential natural communities.

Keys et al. (1995) applied the national ecological framework to the Eastern United States down to the subsection level. The Green Mountain National Forest sits within the Warm Continental Division, with most of the Forest within the Mountain portion of this Division. Divisions are represented more locally by broad recognizable ecoregions. The mountains of New England and the GMNF are associated with the Adirondack-New England Mixed Forest-Coniferous Forest-Alpine Meadow Province (M212). This province is divided into sections representing the different large mountain ranges, with the Green Mountains, Taconics, and Berkshires combined into one section. This section is divided into three subsections on the GMNF representing the southern and northern Green Mountains, and the Taconic Mountains. A small portion of the Forest along the northwestern edge falls within the Champlain and St. Lawrence Valley section in the hierarchy, and represents the transition between the mountainous and non-mountainous regions of the Warm Continental Division.

Land type associations (LTAs) are broad ecological categories that describe landscapes associated with a particular subsection. LTAs reflect differences in geomorphology, surficial geology, elevation, relief, and potential natural vegetation. Each LTA for the GMNF consists of one of the seven general landscape types nested within at least one of the four ecological sub-sections that occur on the Forest (Burbank et. al. 1999). For example, the Valley Bottom general landscape forms a separate LTA in each of the four subsections where it occurs. LTAs on the GMNF include 18 unique permutations of seven general landscape types and four ecological subsections that are found on the Forest: Each LTA is characterized by its potential natural vegetation (PNV), which is the assemblage of plants that would form over time, given the prevailing climatic conditions and historical disturbance regimes.

**GMNF LTAs:**

**Valley bottom** – alluvial or glacio-fluvial substrates associated with rivers, generally below 1,500 feet elevation. PNV is mostly hemlock forests mixed with beech, maples, birches, and oaks. There is very little of this LTA on the Forest, although it occurs in four subsections. This LTA is found in all subsections of the GMNF.

**Low mountain/small hill** – transitional, low- to moderate-relief landscapes between the Green Mountains and its foothills, and along the perimeter and low slopes of the mountains, generally between 600 and 2,400 feet in elevation. PNV is northern hardwoods, primarily beech, with maples, hemlock, and birches. This LTA is found in all the mountain subsections of the GMNF.

**Mountain slope** – steep, high-relief terrain along the slopes of major mountains and mountain ranges, generally below 2,400 feet elevation. PNV is a mixture of spruce and beech; maples, hemlocks, and birches are less dominant. This LTA is found in all the mountain subsections of the GMNF.

**Upper mountain slope** – steep slopes with high relief, shallow soils, and rocky outcrops, above 2,400 feet elevation. This landscape is also characterized as the subalpine zone. PNV consists primarily of spruce and fir; birches are common but beech and maple tend not to be. This LTA is found in all the mountain subsections of the GMNF.

**Alpine** – thin to non-existent soils and harsh climatic conditions above 3,500' elevation. PNV is krummholz (small-stature spruce and fir) and alpine meadow. This LTA is found only in the Northern Green Mountains subsection.

**Escarpment** – a series of cliffs and steep slopes dividing the Green, Taconic, and Berkshire Mountain Section from the Champlain and St. Lawrence Valley Section in the north, and dividing the Taconic Mountains from the Green Mountains in the south. PNV consists primarily of hemlocks and pines mixed with oaks and northern hardwoods. This is the LTA on the Forest where oak is most likely to be found. This LTA is found only in the Northern and Southern Green Mountains subsections.

**Precambrian Plateau** – low-relief landscape dominated by resistant, acidic, Precambrian bedrock at elevations around 2,500 feet. PNV includes northern hardwoods and softwoods of spruce, fir, and hemlock intergrading at small scales. Many of the wetlands and high elevation ponds on the GMNF fall within this LTA. This LTA is found only in the Northern and Southern Green Mountains subsections.

**History and Land Use**

The Green Mountains have provided an important living, working, and spiritual environment for people since the glaciers melted more than 10,000 years ago. European-Americans arrived approximately 250 years ago; they saw Vermont and the Green Mountains as a source of timber, charcoal, iron ore, gravel, farm-lands, pasture, orchard-lands, clean water, water power, and most recently, recreation opportunities. Evidence of past land-uses and activities, and their effects on ecosystems, is contained in archaeological, historic, and traditional use landscapes, travelways, sites, buildings, structures, cemeteries, features, and artifacts.

The Archaic Period (from 9,500 to 2,500 years ago) saw a florescence of ritual activity and diversification of subsistence strategies; most of these archaeological sites reflect hunting, fishing, camping, resource acquisition (for example, stone quarries), and tool making activities.

The most recent pre-Contact cultural horizon, the Woodland Period (from 2,500 to about 400 years ago), is characterized by increasingly intensive agriculture, the introduction of the bow-and-arrow and pottery, a settlement pattern marked by larger, more-sedentary villages, and an increase in social complexity. Village sites associated with this period tend to be larger and reflect a correspondingly more diverse set of activities. Outlying camps, often at higher elevation, tend toward smaller, single function character.

During the Contact Period (roughly the century following Champlain's 1609 explorations of interior New England and Lake Champlain) explorers, traders, missionaries, and settlers converged on the Green Mountains from the north (French), west (Dutch), and south and east (English). The Western Abenaki claimed most of what is now Vermont (and surrounding pieces of Quebec, New Hampshire, Massachusetts, and New York), whereas the Mahican considered most of the upper Hudson drainage, or present Bennington County, to be theirs. Sites from this time period often show a fascinating mix of materials and behaviors derived from both Native and European cultures. New diseases, economic systems, military conflicts, religious beliefs, and technologies threw the indigenous peoples' societies into turmoil. The Mohican community was forcibly moved to reservation-life in the late 18<sup>th</sup> century, enduring several moves over a number of decades before finally arriving on their present Wisconsin reservation in the 1860s (where they are now known as the Stockbridge-Munsee Band of the Mohican Nation). They still have a strong interest in their ancestral homelands today. The Abenaki community has largely persisted in place, although in a somewhat reduced state, until today. Over the last 25 years there has been a renaissance of cultural values and tribal pride among the Western Abenaki, particularly in northern Vermont.

In the lands that are now managed as the Green Mountain National Forest, French and English exploration and some limited homesteading occurred in the 1600s and early- to mid-1700s, but permanent settlement increased dramatically with the relative security that came after the conclusion of the "French and Indian" War and American Revolution. The landscape changed dramatically as settlers cleared forests for farmland, lumber, fuel wood, and potash. In the early nineteenth century, farming and lumbering were the chief sources of income, while iron mines and charcoal kilns were well represented in the working landscape as well. The mid-nineteenth century saw the introduction of the railroad to Vermont, and an agricultural transition from subsistence farming to sheep and then to dairy production, while logging continued to be an important economic pursuit.

By the Great Depression of the 1930s, many upland farms finally met their demise, after a long economic decline and a shifting population that followed the introduction of the railroads, the Civil War, and the opening of the West. The combination of available or abandoned upland farmlands, an increasingly strong conservation movement, and the devastating effects of the 1927 flood (attributable, in part, to the inability of deforested uplands to hold water) led to the establishment of the GMNF in an effort to protect watersheds. Among the first management acts on the new Forest was the establishment of Civilian Conservation Corps (CCC) camps.

As a consequence of changes in land use, the forested proportion of Vermont declined from about 80 percent in 1780 to 25 or 30 percent by the mid-1800s (Garland 1977, Johnson 1998, Klyza and Trombulak 1999). The effects of these land use changes on wildlife were dramatic. Large predators like the wolf, coyote (*Canis latrans*), cougar (or mountain lion), and lynx were extirpated, and game animals like the white-tailed deer (*Odocoileus virginianus*), elk (*Cervus elaphus*), caribou (*Rangifer tarandus*), black bear (*Ursus americanus*), and wild turkey (*Meleagris gallopavo*) were seriously depleted or extirpated by hunting and habitat loss (DeGraaf et al. 1992, DeGraaf and Yamasaki 2001). Over the years, and particularly after the 1930s, abandoned fields and pastures reverted to forest. By 1980, Vermont was at least 75 percent forested again (Johnson 1998).

### **Air Resources**

The GMNF is located northeast, or downwind, of the industrialized Ohio River Valley. This industrialized area produces the greatest amount of air pollution in the United States. Pollutants also originate in the Green Mountain region; these include emissions from motor vehicles, aircraft, railroads, homes, offices, industry, and agricultural machinery.

The current condition of air quality on the GMNF is described in the Green Mountain and Finger Lakes Air Quality Assessment Package (Sams 2002). As described in this assessment, the Forest has some of the best air quality in the nation (Sams 2002: p.2) as evidenced by Vermont meeting the ambient air quality standards for all pollutants regulated by EPA.



Despite this, the GMNF experiences moderately high deposition of sulfates, nitrates, and mercury, especially at mid- to higher elevations on the GMNF (Sams 2002: pp.11, 13, 34). This deposition is of concern because the naturally acidic soils on the Forest have a limited ability to buffer the effects of atmospheric pollutants. Studies of the effects of atmospheric deposition on the GMNF began in the 1980s, initially by the State of Vermont - Agency of Natural Resources, and the USDA - Forest Service Northeastern Research Station. These agencies continue to study these effects today, much of it coordinated with the Vermont Monitoring Cooperative (see also <http://vmc.snr.uvm.edu/summary/general012.htm>).

Based on monitoring conducted on the GMNF and other sites in the Northeast, air pollutants may pose a risk to forest health (Sams 2002: p. 34-42; Tetra Tech 2003: pp.23-25). The most important, well-documented impacts are:

- Air-borne particulate matter has decreased visibility on the GMNF by 25 to 50 percent in comparison to estimates of natural visibility (Sams 2002: p.24).
- The State of Vermont classifies several high-elevation ponds on the Forest as “impaired” due to the effects of atmospheric deposition (Donna 2004: pp.C23-24).
- Vermont and several other states issued full or partial advisories alerting the public to the health risks of consuming fish taken from local waters because of mercury contamination ([www.epa.gov/ost/fish](http://www.epa.gov/ost/fish) in Sams 2002, <http://www.state.vt.us/health/record/pdf/fishalert00.pdf>).

### **Aquatic Resources**

The GMNF is draped over the southern and central Green Mountains and the northern Taconic Mountains. About half of the land drains to the East toward the Connecticut River, while the other half drains west toward Lake Champlain and the Hudson River. The Lake Champlain, Hudson, and Connecticut River watersheds are the three major watersheds on the Forest. Within these watersheds, the proclamation boundary of the Forest and Appalachian Trail Corridor are together comprised of 63 12-digit (HUC 12) subwatersheds, ranging in size from 10,000 to 50,000 acres. Average annual precipitation is 52 inches on the south half of the Forest, and 46 inches on the north half. Estimated water yield for the GMNF is 939,881 acre-feet annually (323,350 ac. ft. on the north half, 616,530 ac. ft. on the south half (Randall 1996).

The Forest includes more than 450 miles of perennial streams and a large number of intermittent or seasonal streams. Drainage patterns for these streams are generally dendritic and characterized as having moderate to steep gradients with rapidly moving water. There are almost 400 waterbodies on the Forest, around half of which are at least an acre in size, but only 30 of which are 10 acres or larger in size. There are also a large number of wetlands of various types and sizes, accounting for approximately 6,400 acres. Wetlands are formed in riparian areas along streams, at the heads of drainages, and in flat or concave landforms like benches and depressions.

Source protection areas and well head protection areas (areas of drinking water sources used by municipalities and/or private individuals) require protection in order to maintain the highest water quality standard. There are 27 such protection areas that are totally or partially within National Forest ownership. There is also one pond that is used for snow-making.

Aquatic habitats on the GMNF include a range of low to high-elevation streams, ponds, lakes, and reservoirs that provide both cold-water and warm-water habitats for a variety of native and introduced fish, macro-invertebrates, and amphibians. High elevation streams generally support brook trout, slimy sculpin, and blacknose dace. Larger streams at moderate and low elevations commonly support longnose dace, white sucker, creek chub, common shiner, tessellated darter, fallfish, rainbow trout, brown trout, and Atlantic salmon. Most ponds provide cold-water habitat for native brook trout, although little or no natural reproduction occurs there. Grout Pond and Wallingford Pond provide warm-water habitat for species such as smallmouth bass, chain pickerel, yellow perch, and brown bullhead. Large reservoirs on or near the Forest, such as Chittenden, Somerset, and Harriman, support both cold- and warm-water fisheries.

**Terrestrial Resources**

The Green Mountain National Forest lies within the highly metamorphosed and mineralized Green Mountains. Deposits of marble, limestone, dolomite, ultramafic and pematitic rocks, and natural gas are known from the Forest (Romito 2004), but usually do not occur in commercial quantities. Gold deposits have been known since the 1850s in Vermont, but they have always been relatively small, erratically-distributed, and economically marginal. Stream and glacial deposits of sand and gravel occur, especially along stream valleys and lowland areas. There are no known large deposits on the Forest and the sand and gravel industry is not a major presence there.

Most soils on the GMNF are formed from acidic, loamy, glacial tills, but about 5 to 10 percent are at least partially formed from calcium-rich parent material. Soils range in pH from 4.0 to 8.0, with a range of 4.5 to 5.5 being most common. Soils formed from calcium-rich parent material typically have a pH within the high end of the overall range. Slopes range from 0 to 70 percent, with most between 15 and 35 percent. Soil depth to bedrock ranges from 0 to over 60 inches, with dominant condition 30 to 60 inches. In general, soil depth increases as elevation and slope steepness decrease. Soils on ridge tops and side slopes are generally well to moderately well drained, while those on toe slopes, bottomlands, and other concave landscape positions are generally moderately-well to poorly-drained.

Compared to the rest of New England, GMNF soils support moderate to high forest productivity. Exceptions are wet, steep, or shallow soil areas, where soil nutrient levels are low. Soil quality on the GMNF has been affected by past land management. Much of the forest was cleared for agricultural uses in the early to mid-1800s, later abandoned (partly due to erosion), reforested, and then logged repeatedly in the early to mid-1900s. Erosion control efforts and conservation measures in the latter half of the twentieth century have improved the quality of the soil. Currently, questions remain regarding the extent to which atmospheric deposition (the result of air pollution) is altering the soil nutrient content and thus soil quality.

Vegetation on the GMNF can be grouped into five major types: northern hardwood forests of beech, birch (yellow and paper birch), and maple (sugar and red maple), and including aspen; softwood forests of red spruce and balsam fir, hemlock, white pine; mixedwood forests that are transitional between northern hardwood and softwood forests and have elements of both; oak forests of primarily red oak, usually mixed with northern hardwoods, pines, or hemlock; and open lands that are mixtures of trees, shrubs, and forbs, representing both uplands and wetlands. Forested conditions are found on 97 percent of the GMNF, with 79 percent classified as northern hardwoods, 10 percent as mixedwoods, 7 percent as softwoods, and 1 percent as oak. Open lands and small stands of aspen and paper birch are maintained to provide wildlife habitat. About half of the forested lands are available for management using timber harvesting under the 1987 Plan. About two-thirds of the Forest is less than 100 years old due to land use history in the area. At the other end of the spectrum, there are about 700 acres of documented old growth on the Forest. Prior to European settlement, the GMNF had a higher proportion of forest in the mixedwood type and a lower proportion in northern hardwoods than currently. Oaks and softwoods were also slightly more common than they are now.

More than 300 wildlife species, 17 fish species, and over 400 vascular plant species occur on the GMNF. Whereas five federally-listed threatened or endangered species occurred historically on the GMNF, only two of these species (Indiana bat and bald eagle) are currently known to occur on or near the GMNF (USFWS 2004, USFWS 2006). No critical habitat for any federally-listed threatened, endangered, or proposed species has been designated on the GMNF (USFWS 2004, USFWS 2006). Species of viability concern that may be rare or declining on the GMNF or in the region include 27 animals and 83 plants. The GMNF provides a diversity of habitats for animal and plant species. Habitats that are of particular importance to species in this area include grassy or shrubby openings, young deciduous trees, upland forest of northern hardwoods and conifers, enriched northern hardwood forests, old forest conditions, wetlands, riparian areas, and aquatic habitats. Management Indicator Species (MIS) also address several other wildlife habitat issues, including wintering habitat for white-tailed deer, early successional habitat, habitat for reclusive species, and stands of aspen (and aspen-birch) and oak (and oak-pine). All of these habitats occur currently on the GMNF.

## Management Direction

### **Goals and Objectives**

Goals and objectives for management of the GMNF can be found in Chapter 2 of the revised Forest Plan. Projects are undertaken across various management areas in order to meet resource specific goals and objectives. The Forest is valued for its diverse habitats and biodiversity, wood, forage, and other products, the multiple services available on the National Forest System lands, and the Forest Service commitment to preserve long-term productivity. For these reasons, the Forest Service is strongly committed to the continuation of multiple use management, and the sustainability of the many natural resources of the GMNF. Management goals include providing for clean water, air, productive soils, and a diversity of plant and animal life. The Forest Service is committed to promoting an awareness of natural resource management and a strong conservation ethic to highlight the GMNF dedication to careful stewardship of the land for present and future generations.

Goals and objectives that are relevant to federally-listed, threatened and endangered species and Regional Forester sensitive species (TE species and RFSS, respectively, or cumulatively TES species) are primarily associated with Goal 2, which requires the Forest Service to maintain and restore quality, amount, and distribution of habitats to produce viable and sustainable populations of native and desirable non-native plants and animals. Objectives under this goal include those for habitat composition, age-classes, and habitat features important to wildlife, similar to those in the current Plan. Other objectives for this goal include those that require the Forest to protect key habitat and habitat features for TES species; to work toward recovery of federally-listed, threatened or endangered species; to develop conservation strategies for RFSS species; to maintain or enhance habitats for sensitive species through conservation strategies or habitat management; to cooperate with resource management agencies of the State of Vermont on habitat management for species of State concern; to maintain fish populations through habitat work, and to minimize the effects of non-native invasive species (NNIS) that can compete with and overcome native species. Goals 3 through 7 and the associated objectives provide direction for maintaining and restoring terrestrial and aquatic ecological systems and habitats, which support the viability of species associated with those habitats.

### **Standards and Guidelines**

Standards and guidelines (S&Gs) for each resource are described in Chapter 2 of the revised Forest Plan. Management activities that take place on the GMNF are guided by federal laws, regulations, and departmental and agency policy found in the agencies' manuals and handbooks. Of particular relevance to threatened and endangered (TE) species are the Endangered Species Act and the National Forest Management Act, and their associated regulations and policies. Forest Plan S&Gs supplement this direction by recognizing resource conditions on the GMNF and considering state regulations in Vermont. Forest Plan S&Gs can be stricter than laws, regulations, and agency policy, but cannot be more lenient. The 1987 Plan for the GMNF was updated in April, 2002 (USDA 2002b), with an amendment making adjustments to S&Gs for TE species and Regional Forester sensitive species (RFSS). Due to this amendment, the abundant management direction found in these laws, regulations, and policies for TES species (TE species and RFSS, collectively), and the low number of occurrences of TES species on the GMNF, few additional S&Gs are currently needed for species conservation.

The revised Forest Plan updated S&Gs for TES species to remove requirements that are redundant with agency policy, and to organize the information more clearly among objectives, standards and guidelines, monitoring, and information not appropriate in a Forest Plan. The revised Forest Plan includes updated S&Gs that address retention of snags and trees as nest, roost, and den habitat for wildlife. The Forest Service initially derived these S&Gs directly from the Biological Opinion and Incidental Take Statement provided by the USFWS (2000b) for the expressed purpose of reducing possible adverse impacts to Indiana bats. During Forest Plan revision, the Forest Service revised these S&Gs in consultation with bat experts from the Forest Service, the US Fish and Wildlife Service, the Vermont Fish and Wildlife Department, and the University of Vermont. The revised Forest Plan maintains S&Gs that protect nesting sites of bald eagles and peregrine falcons from disruptive management and recreational activities. The revised Forest Plan deleted S&Gs addressing protection around common loon nests. Site-specific

conditions at individual loon nests vary considerably, making uniform guidelines inappropriate. The GMNF will continue to work in close cooperation with the Vermont Fish and Wildlife Department and the Vermont Institute of Natural Science to monitor loon nesting activity throughout Vermont, including on the GMNF, and immediately provide protection where and when warranted. A standard to protect particularly vulnerable roadside populations of Jacob's ladder was also added.

S&Gs and additional management direction for other resource areas can also influence TES species and their habitats. This direction is summarized below.

#### Water Resources Management

Management of water resources consists primarily of restoration of aquatic habitats that have been degraded by historical land uses. The revised Plan continues the 1987 Plan direction to protect the integrity of water resources and life-supporting functions. It also clarifies that maintaining or improving water quality includes the protection and restoration of riparian areas, and associated ecological process and functions such as filtering sediments and providing woody debris for habitat creation. Wetland protection specifically includes protection for seeps and vernal pools. The revised Plan makes water resource standards and guidelines align with best management practices (BMPs) in Vermont, and monitoring of streams and ponds is emphasized. Between 1986 and 1997, the Forest Service installed about 3,641 structures on the GMNF to enhance aquatic habitat.

#### Forest Resources Management

The Forest Service employs various silvicultural methods, including both even-aged and uneven-aged management systems. Selection of a specific treatment is determined by the desired future condition for the particular management area, levels of outputs envisioned by the revised Forest Plan, and the resource conditions that exist within the stand.

##### *Even-aged silviculture*

Even-aged silvicultural techniques are used where long-term objectives are to manage for trees that are relatively close in age (within twenty years), for an established length of time (rotation age), with the eventual intention to establish a new stand of seedling regeneration to replace the trees currently in place. This type of management can be accomplished by applying a series of treatments throughout the life of the stand, some of which take place during the initial phases of stand development (regeneration treatments, pre-commercial thinnings), some during the mid-life of a stand (intermediate thinnings, timber stand improvements) and some nearing the rotation age for the stand (reforestation treatments to establish seedlings, regeneration harvests such as shelterwoods or clearcuts). This system is most often used to regenerate tree species that require moderate to high amounts of light to regenerate. For the most part, seedlings are produced through natural regeneration processes. Sometimes, artificial regeneration (planting) is used when seed source is lacking or seedlings fail to develop. Repeating even-aged treatments across the landscape results in a multi-aged forest composed of even-aged stands. The following describes the various treatments in an even-aged silvicultural system.

1. Intermediate thinnings - The objective of this treatment is to maximize volume yield by removing lower quality trees and by salvaging trees that would otherwise die; to concentrate growth on the better trees; and to improve growing conditions for remaining trees. This is accomplished by reducing the number of trees in stands that are above 80 percent relative density (which equates to canopy closures above 71 percent) to approximately 60 percent relative density (54 percent canopy closure). Most thinnings occur in stands that are over 90 percent relative density (79 percent canopy closure). Trees to be removed are concentrated in the smaller diameter classes, leaving the larger, healthier trees on site. More open canopy conditions may persist for 15-20 years following the thinning.
2. Shelterwood system - The objective of this treatment is to establish seedling regeneration through the application of 1 or 2 preparation or seed cuts, followed by the almost complete removal of overstory trees in a removal harvest. Relative density is reduced from above 80 percent to 30-40 percent in the shelterwood seed cut. A reduced forest canopy permits greater amounts of sunlight to reach the forest floor and seedling growth is stimulated. It may take from 3 to 10 years for adequate seedlings

to germinate and become established. Once adequate numbers of seedlings are in place, a shelterwood removal can be completed to permit the seedlings to grow in full sunlight.

Where appropriate, residual stems of mast trees (such as American beech) and softwood trees (such as eastern hemlock) are retained for wildlife purposes. In all stands, Forest Plan standards and guidelines require that at least five den, nest, roost, and snag trees (combined) be retained per acre during these management activities. Management direction emphasizes retention of potential roost trees (trees of suitable species and those with exfoliating or rough bark, crevices, hollows, or broken tops) and those likely to develop into suitable roost trees in areas where Indiana bats are likely to occur.

3. Shelterwood with Reserves system - The objective of this treatment is to establish seedling regeneration of shade tolerant species (sugar maple, American beech, red maple) in areas where the second cut of a standard shelterwood is delayed for 40 to 60 years. Relative density is reduced from above 80 percent to 30 percent or 40 percent in the first cut (seed cut) of the shelterwood. The increased amount of sunlight reaches the forest floor and seedling growth is stimulated. Trees that need high levels of sunlight (yellow birch, white ash, black cherry) do not regenerate as well in a shelterwood with reserves system when compared to a standard shelterwood system of regeneration cutting.

Where appropriate, residual stems of mast trees (such as American beech) and softwood trees (such as eastern hemlock) are retained for wildlife purposes. In all stands, Forest Plan standards and guidelines require that at least five den, nest, roost, and snag trees (combined) be retained per acre following the removal cut. Management direction emphasizes retention of potential roost trees (trees of suitable species and those with exfoliating or rough bark, crevices, hollows, or broken tops) and those likely to develop into suitable roost trees in areas where Indiana bats are likely to occur.

4. Clearcut - The objective of this treatment is to remove trees in stands where adequate numbers of seedlings exist in the understory, or to remove trees by cutting the existing stand which allows seedling regeneration to develop after the cut occurs. On the GMNF, this treatment is currently used to regenerate aspen, to regenerate growth in diseased or damaged stands, or to convert non-native softwood plantations to native hardwood forests.

The Forest Service revised the GMNF S&Gs for wildlife reserve trees to include retention of uncut patches totaling five percent of the harvested area during even-aged management (when harvest reduces the basal area of a stand below thirty square feet per acre). Patches of retained trees should be at least one-quarter acre in size, encompassing as many den, nest, roost, and snag trees as possible.

During the time period of 1987 through 2001, the GMNF harvested timber on an average of about 1,600 to 1,700 acres per year (USDA 2002a). About 1,000 acres per year were harvested using even-aged techniques. Clearcut accounted for an average of only about 180 acres per year. Clearcuts were primarily on upland areas, for regeneration of shade-intolerant hardwoods, conversion or release of softwood stands (particularly for deer wintering areas), and maintenance of aspen. Shelterwood harvests and thinning harvests accounted for about 350 and 400 acres per year, respectively (USDA 2002a).

#### *Uneven-aged silviculture*

Uneven-aged silvicultural techniques are used where long-term management objectives are to maintain continuous forest cover with a variety of age and size classes present within the same stand. Management activities occur periodically (approximately 20 years apart) with each entry intended to establish some seedling regeneration. The objective for selecting an uneven-age treatment may vary, but often it is related to visual, recreational or site (wetness) concerns. It is most often used to regenerate tree species that require moderate to high levels of shade to become established. The factors considered in the application of an uneven-aged harvest are the same as those considered in even-aged - stand density, stand structure and species composition - however the type of structure and composition are

quite different than those sought under even-aged treatments. The Forest Service employs three types of uneven-aged treatments on the GMNF.

1. **Improvement Cut** - The objective of this treatment is to modify the age and size class distribution of an even-aged stand to that of an uneven-aged stand by removing designated trees through commercial harvest. By reducing the overstory to 60 percent of full stocking, and concentrating these removals in specific age and size classes, residual stand structure will become more like that of an uneven-aged stand. Some seedling regeneration may become established in this kind of harvest; however more emphasis would be placed on seedling establishment in subsequent entries.
2. **Individual Tree Selection** - The objective of this treatment is to maximize volume yield by removing lower quality trees and by salvaging trees that would otherwise die; to concentrate growth on the better trees; and to open the canopy enough to foster the development of a new age class after every cut. This is accomplished by reducing the number of trees in stands that are above 80 percent relative density (which equates to canopy closures above 71 percent) to approximately 60 percent relative density (54 percent canopy closure). Most selection harvests occur in stands that are over 90 percent relative density (79 percent canopy closure).
3. **Group Selection** - This treatment is similar to individual tree selection, but varies by the removal of small clumps of trees (usually less than 0.25-0.5 acre in size) in conjunction with removals similar to the individual tree selection. Post-harvest density will average slightly lower than in individual tree selection to as low as 50 percent relative density (45 percent canopy closure).

During the time period of 1987 through 2001, the Forest Service used selection cuts on an annual average of 358 acres of hardwood and 84 acres of softwood on the GMNF (USDA 2002a). This method was used primarily in highly sensitive visual areas such as roadsides, trail and recreation sites. It was also used in riparian areas to maintain shade along streams.

#### *Reforestation*

Reforestation techniques are included in both even-aged and uneven-aged regeneration systems. The goal of any regeneration harvest is to establish a new age class of seedlings to replace trees being removed. The primary difference between even-aged and uneven-aged treatments is that in even-aged management, the entire stand is regenerated at once, within a relatively short period of time and results in a stand composed of trees of the same age. Uneven-aged treatments are intended to produce fewer numbers of seedlings in every entry and results in a stand composed of trees that vary in age, with continual replacement of trees over time. The same reforestation treatments (site preparation) can be effective in both even-aged and uneven-aged systems.

Seedling regeneration on the GMNF is generally not a problem, with the possible exception of oak. Seedlings, shrubs and smaller trees are generally present in most stands or readily regenerate naturally. Understory vegetation is sometimes dominated by brush, beech, and striped maple. Seedling development of a greater diversity of desirable species can sometimes be achieved more effectively by completing reforestation treatments such as removal of competing vegetation (beech and striped maple) or by providing optimal light conditions through removal of shade with a regeneration harvest such as a shelterwood seed cut, or an individual or group selection harvest.

#### *Special Forest Products*

The GMNF currently issues permits for collection of eight products, including maple sap, Christmas trees, boughs, saplings, seedlings, dead/down wood, miscellaneous sawtimber/pulp, and firewood. While some of these products are gathered for commercial purposes, most are for personal use. Under Forest Service policy, permits are generally not required for gathering of minor amounts of products, such as cones, mushrooms, berries, acorns, or nuts, as long as these products are intended for personal use, and as long as they can be harvested sustainably. Permits are required for products that are gathered in larger amounts, involve improvements on the ground, are intended for sale by the gatherer, have value

that can be appraised and recovered by the Government, are in limited supply, or otherwise require controls on use in order to maintain viability of species or sustainability of gathering.

Gathering of special forest products for commercial sale is prohibited in Wilderness, Remote Backcountry Forest, Alpine/Subalpine Special Areas, existing and candidate Research Natural Areas (RNAs/cRNAs), Ecological Special Areas, Recreational Special Areas, Wilderness Study Areas, and Newly Acquired Lands. Agency policy on management of Wilderness and RNAs/cRNAs further restricts collecting to incidental use in those areas, with limited exceptions allowed in RNAs/cRNAs for gathering by permit for research purposes. Remote Wildlife Habitat, Green Mountain Escarpment, Remote Backcountry Forest, Alpine/Subalpine Special Area, and Ecological Special Area management areas require that any collecting of special forest products be consistent with the desired future condition of the areas, which will place some limitation on the size and scale of gathering activities. As in the 1987 Forest Plan, the Newly Acquired Lands management area allows for existing permit uses but not new permit uses.

#### Insects and Disease

Populations of gypsy moth, forest tent caterpillar, maple leaf cutter, and saddle prominent periodically build up in localized areas. Impact on the annual growth of trees defoliated by these insects may be substantial, but these insects seldom kill trees and their effect on the total forest growth is insignificant. Beech bark disease has killed beech trees since the 1960s, but has not substantially reduced the abundance of beech trees on the Forest.

The most serious tree diseases on the GMNF are beech bark disease and Armillaria root rot, which attacks red spruce. These diseases have caused loss of beech and red spruce on the Forest for the past two decades and future losses are expected.

The revised Plan emphasis includes a proactive approach to maintaining the health of forest ecosystems rather than the 1987 Plan focus of protecting specific forest resources. Forest health is a national issue and there is a need to maintain ecological resiliency, rather than focus protection efforts on individual resources, such as timber. As in the 1987 Plan, the revised Plan retains specific direction for the use of biological, silvicultural, or chemical controls in forest-wide and management area standards and guidelines. Chemical controls will only be used when other methods are ineffective.

#### Wildlife Habitat Management

The wildlife habitat management strategy on the Forest through the revised Plan is to provide a diversity of vegetation types and structures. Each alternative approaches the proportions of types and structure differently, although all maintain or improve on the current diversity of habitats on the Forest. Timber and vegetation management are important tools for management of wildlife habitat.

Individual management area (MA) prescriptions provide varying opportunities in both levels and types of vegetation management. Thus, the varying allocation on lands to MAs in the five alternatives produces five different scenarios for management of wildlife habitat. Habitat management on the GMNF typically includes timber sales in mature forest communities, and a combination of burning and cutting in openings managed for wildlife. Additional wildlife projects included such things as enhancement of cavity nesting habitat through the placement of nest boxes, and release and maintenance of historical apple orchards and berry areas for soft mast production.

Between 1987 and 2001, around 650 acres were improved for wildlife every year through burning and other non-commercial activities (USDA 2002a). Wildlife enhancements include such actions as planting of shrubs, creation and maintenance of openings, and release of desired shrubs and trees. Naturally occurring openings that exist on the landscape as wetlands, barren areas, and old fields, are usually maintained for wildlife values. Almost 30 acres of forest are converted to wildlife openings per year. These conversions occur across all timber types. An attempt to re-introduce pine marten on the GMNF in the early 1990's was unsuccessful (Trombulak and Royar 2000, VFWD 2005a).

### Roads Management

The GMNF road system includes approximately 434 miles of roads; 250 miles (58%) are under Forest Service jurisdiction and 184 miles (42%) are under State, town, or private jurisdiction. Roads under non-FS jurisdictions are scattered throughout the Forest and are essential links in the road system that provides access throughout National Forest System (NFS) lands.

The revised Forest Plan will continue the management direction for transportation systems provided in the 1987 Plan. The revised Plan objectives emphasize using design elements and standards to maximize economy, while meeting management direction for resource and environmental protection, and user safety. This will be accomplished by constructing or reconstructing roads to accepted federal and State standards. There have been only minor enhancements to forest-wide standards and guidelines for the GMNF transportation system. Standards still mandate the use of Forest Service manual direction and American Association of State Highway and Transportation Officials (AASHTO) policy for road design. Some additional standards regarding drainage structures, stream crossings, and in-stream structures will clarify mitigation for free movement of aquatic life and fish. There is also further clarification on year-round or seasonal road restrictions. Management area standards and guidelines for transportation systems provide explicit direction regarding road construction and use for each MA. Direction was clarified and updated regarding road prohibitions and decommissioning in Wilderness Areas, Remote Backcountry Forest and Diverse Backcountry Forest MAs.

### Recreation Management

The GMNF lies within a day's drive of one-third of the Nation's population and receives over 3 million visitors annually, based on a 2000 survey. The GMNF is a popular recreation destination in Vermont as well as regionally in the northeast. Historically the role of the National Forest has been to provide high-quality scenery and opportunities for camping in undeveloped settings, as well as dispersed recreation such as hiking, horseback riding, hunting, and fishing. The GMNF provides multiple recreation opportunities in predominantly natural settings within a region of dense populations and urban settings.

Recreation facilities include:

- 53 trailheads
- 9 campgrounds
- 1 swimming area
- 35 trail shelters and tent areas
- 6 picnic sites
- 2 fishing/wildlife viewing sites
- 4 interpretive sites
- 4 observation sites
- 3 alpine ski areas
- 7 nordic ski areas

The GMNF trail system includes 906 total miles of designated trails. Some trails allow multiple uses, whereas others are designated for single uses. For each type of use, the miles of trail system available include:

- 349 miles of hiking trails
- 166 miles of cross-country skiing trails
- 37 miles of bicycling trails
- 14 miles of horseback riding trails
- 471 miles of snowmobile trails

Revised forest-wide and MA-specific standards and guidelines contain updated information about the construction and maintenance of trails and changes in use designations. Motorized trail uses in the revised Forest Plan in two categories: snowmobiles and summer off-road vehicles (ORVs). The revised



Forest Plan is more explicit than the current Plan about where future motorized trails may be developed across the Forest. The Forest Service may consider designation of new snowmobile trails in several MAs: Diverse Forest Use, Diverse Backcountry, Moosalamoo Recreation and Education Area, White Rocks NRA, Alpine Ski Area, Alpine Ski Area Expansion, and Eligible Scenic and Recreation River corridors. The Forest Service will not provide a self-contained, summer ORV trail system on the GMNF; rather it will consider proposals to construct links that join larger, public trail systems located on non-Forest Service lands. Future summer ORV trails will be considered only within Diverse Forest Use and Diverse Backcountry; they also may cross Eligible Recreation River corridors. All future trail development or changes in use designation will be based on demonstrated demand for specific recreation opportunities.

#### Wildland Fire Management

Montane forests in the GMNF region lack significant fire regimes. Historically, disturbances ranged from large blowdowns (e.g. hurricanes) to single-tree gaps. These disturbances created interior forest openings, which are extremely important to a majority of wildlife species inhabiting the forest (M. Yamasaki, personal communication *cited in* USDA 1999). Currently, the Forest Service uses prescribed fire effectively to create and maintain interior forest openings, as well as other openings at historic cultural sites, such as homesteads and farm fields. Between 1987 and 2001, the Forest Service treated an average of 314 acres of openings with prescribed fire each year (USDA 2002a).

Fire regimes historically were very different within the Green Mountain Escarpment landscape, which is along the east side of the Route 7 corridor. This landscape has a documented fire regime with an estimated return interval for fires of six to 30 years (average of 14 years), and a return interval for stand-replacing fires of about 150 years (Mann et al. 1994). Several fire-maintained, natural communities occur on the GMNF within the escarpment, including pitch pine-oak-heath rocky summits, natural red pine forests and woodlands, and dry oak forests and woodlands. Fire has been used successfully in this landscape to enhance reproduction of northern red oak. However, use of fire has been limited by the area's high scenic value, very steep slopes, limited road network, and limited natural availability of water.

#### Energy Production and Minerals Management

Several water and wind power sites have been developed near the GMNF, but no actual generating sites are on the National Forest. Several sites along the main ridge of the National Forest are potentially suitable for wind energy development. An estimated six to sixteen percent of the GMNF meets the criteria for being commercially attractive for wind power development. One current wind power generating site is close enough to the GMNF to consider expansion onto the Forest if there was interest. Numerous small streams with steep gradients have suitable physical characteristics for hydropower developments on the National Forest. There are currently 15 permits for water systems or reservoirs, but these permits account for only about five acres of land on the National Forest.

Potentially valuable sand and gravel sources are present in the National Forest. There is only one sand and gravel permit currently on the Forest, although five sources are available for administrative use. These sand and gravel sources are generally small "borrow pits" used by the Forest Service and local road agencies for the construction and maintenance of roads. There is no history of interest in the "leasable" minerals on the Forest, and little interest is expected in the future.

#### Management Areas

The revised Plan divides the Forest into 20 management areas (MAs). Because Alternative A is the "No Action" or "Current Management" alternative, MAs created during Plan revision are not available for allocation. These include Remote Wildlife Habitat, Green Mountain Escarpment, Moosalamoo Recreation and Education Area, Alpine/Subalpine Special Area, and Eligible Wild, Scenic, and Recreation Rivers. Alternatives B through E use 17 or 18 MAs; Moosalamoo Recreation and Education Area is used only in Alternatives C and E. Newly Acquired Land and Significant Streams are retained in Alternative A, but these lands are allocated to appropriate MAs in Alternatives B through E. Each MA has a particular emphasis, a desired future condition for the lands within that MA, and a set of standards and guidelines that govern activities undertaken to achieve the desired future condition. Forest-wide standards and

guidelines apply to each MA, although they may be constrained further by those written for a specific MA. Detailed descriptions of the emphasis, desired future condition, and MA-specific standards and guidelines for each MA are contained in Chapter 3 of the revised Plan. The following is a summary of groupings of management areas on the Forest.

#### Diverse Forest Use

The Diverse Forest Use MA emphasizes a variety of forest uses. Vegetation management emphasizes production of high quality sawtimber and other timber products on a sustained yield basis. Management actions provide a mix of habitats for wildlife species, including deer wintering habitat. Public use is managed to provide a full range of recreation opportunities, from motorized and non-motorized trails to dispersed campsites and developed campgrounds. The mix of vegetation conditions and recreation opportunities across the landscape provides a mosaic of landscape conditions that strives to be visually attractive to people visiting the Forest. The Diverse Forest Use MA represents a merger of five different MAs from the 1987 Plan: Uneven-Aged Forest (MAs 2.1 and 2.2), Mosaic of Even-Aged Forests (MA 3.1), and Deer Wintering Areas (MAs 4.1 and 4.2).

#### Diverse Backcountry

The Diverse Backcountry MA emphasizes relatively large landscapes that provide a mix of backcountry recreational experiences from low use foot trails to motorized use trails and longer rotations for timber harvesting (150 years or more) that provide a more mature-appearing forest. The management area will also provide a mix of wildlife habitats supplied by more mature forests, early successional forests and openings. A predominantly natural or natural-appearing environment characterizes the area. This MA represents minor changes from the Semi-primitive Recreation Area (MA 6.2) in the 1987 Plan.

#### Remote Wildlife

The major emphasis of the Remote Wildlife Habitat MA is to provide a mix of different-aged forest habitats, from early succession to old forests, for the primary benefit of diverse wildlife species, including reclusive wildlife species. This MA creates diverse habitats, including permanent upland and temporary openings and brushy areas that complement wildlife habitat management in other MAs. Recreation uses are de-emphasized to minimize continuing disturbance to wildlife. This MA is newly created for the revised Plan.

#### Green Mountain Escarpment

The Green Mountain Escarpment MA emphasizes management of natural communities along the Green Mountain escarpment. The Green Mountain escarpment is a landscape that falls between the eastern edge of the Champlain and Vermont Valleys and the crest of the cliffs and steep slopes that form the western edge of the Green Mountains and the Forest. Several natural communities found in this landscape are rare or uncommon, providing habitat for trees, herbs, and ferns that are considered rare or uncommon on the Forest or within the State. Emphasis is on management to maintain natural community diversity and to maintain or enhance populations of rare or uncommon plant and animal populations. This MA is new in the revised Plan.

#### Remote Backcountry Forest

The Remote Backcountry Forest MA emphasizes large expanses of relatively natural landscapes where terrestrial and aquatic ecosystems develop under natural disturbance regimes. Management actions are limited to those that help restore or maintain natural processes, natural communities, and associated species within their natural ranges of variation in the landscape. Public use is managed at a scale and intensity that either helps keep species or processes within their natural range of variation, or has minimal effect on the area's integrity. Recreation opportunities emphasize hiking and cross country skiing trails that provide a relative sense of isolation and remoteness in a predominantly natural or natural-appearing landscape. This MA represents minor changes from the Primitive Recreation Area (MA 6.1) in the 1987 Plan.

### Wilderness and Wilderness Study Area

The Wilderness MA emphasizes the management and protection of congressionally-designated Wilderness areas. Existing Wilderness areas include Bristol Cliffs, Breadloaf, Big Branch, Peru Peak, Lye Brook, and George D. Aiken. Lye Brook Wilderness is also a Class I Air Quality Area. Management emphasizes the maintenance of wilderness values consistent with the Wilderness Act of 1964 and subsequent legislation. This MA is equivalent to the Wilderness MA in the 1987 Plan.

The Wilderness Study Area MA provides for the management of areas that are recommended by the Forest Service for designation as Wilderness. The focus for management on these areas is to protect wilderness characteristics pending legislation as to their classification, and providing existing uses where compatible with protecting wilderness character.

### National Recreation Area

The White Rocks National Recreation Area (NRA) was established by Public Law 98-322 for the purpose of preserving and protecting “existing wilderness and wild values and to promote wild forest and aquatic habitat for wildlife, watershed protection, opportunities for primitive and semi-primitive recreation, and scenic, ecological, and scientific values.” The White Rocks NRA also includes the Big Branch and Peru Peak Wilderness areas. The emphasis of this management area is to attain the purpose of the public law in the lands that are not included in Wilderness. This MA is unchanged from the 1987 Plan.

### Alpine Ski Area and Alpine Ski Area Expansion

The major emphasis of the Alpine Ski Areas MA is to provide opportunities for alpine winter sports, as well as opportunities for year-round recreation at the three alpine ski areas managed privately under the authority of Special Use permits. This MA is equivalent to the ski area management direction in the 1987 Plan, although it has been separated from the more general Highly Developed Areas (MA 7.1).

The Alpine Ski Area Expansion MA recognizes the potential need for ski area expansion, and manages the land so as not to preclude future ski area development.

### Special Management

There are nine MAs that have a special area management emphasis. These include the Appalachian Trail, Long Trail, Ecological Special Areas, existing and candidate Research Natural Areas, Alpine/Subalpine Area, Recreational Special Areas, Moosalamoo Recreation and Education Area, Eligible Wild, Scenic, and Recreational Rivers, and Significant Streams (Alternative A only).

These management areas emphasize preservation and protection of

- the nationally-significant Appalachian Trail and Long Trail
- protection of areas with uncommon, significant, or outstanding recreational, scenic, cultural, biological, ecological, geological, or historical values
- protection and enhancement of outstandingly remarkable values that make certain rivers eligible for national recognition
- protection of representative or unique ecosystems for research.

The desired future condition for these areas will exemplify the special values for which each is identified. Natural disturbance regimes and management activities will shape the vegetation composition, which will represent much of the diversity of the Forest. In general, Research Natural Areas and candidate Research Natural Areas exhibit less evidence of recent or historical human disturbance than the other special management areas, while the Moosalamoo Recreation and Education Area and Eligible Recreational Rivers will exhibit the most. Management guidance tends to restrict uses that threaten the integrity of these special areas and encourage uses that promote protection of the unique, uncommon, or significant features. Management for TES species is allowed in these management areas. Management for non-native invasive species is allowed in these management areas but may be restricted.

Newly Acquired Land (Alternative A only)

This MA is fully described in the 1987 Plan. The major emphasis of the newly Acquired Land MA is to protect the natural resources and management options of newly acquired lands until analyses are completed to determine the desired future condition of these lands. Management activities are limited to the protection and inventory of existing resources and facilities until such studies are complete and a decision can be made. Lands acquired under the 1987 Plan and retained in Newly Acquired Land under Alternative A are allocated to different MAs under each of the other alternatives. The relative allocation of these lands to particular MAs depends on the emphasis of each alternative.

**Analysis and Management Process**

The suitability and effectiveness of management direction and protective measures relative to TES species are most apparent at the project level.

The revised Forest Plan and Final Environmental Impact Statement, including this Biological Evaluation, are programmatic documents that establish and assess the framework of management direction that the Forest Service will use to identify, analyze, prevent, or mitigate potential impacts of future forest management actions. Some management direction applies Forest-wide, some is specific to individual management areas (MAs).

During scoping and the earliest stages of project planning, the Forest Service identifies and evaluates potential effects a project may have on each resource area. This evaluation includes investigating the project site for the presence of federally listed endangered, threatened, or proposed species, and habitat for these species prior to beginning any authorized ground-disturbing activity at the site. Forest Service staff examine each aspect of a proposed project to insure that it complies with Forest-wide standards and guidelines, as well as the appropriate standards and guidelines specific to each management area allocated to lands within the project area. Forest-wide or MA-specific standards are mandatory management requirements, permissions, limitations, desirable conditions, or in some instances required courses of action, that are applicable to all foreseeable situations. Forest-wide or MA-specific guidelines are management requirements, permissions, limitations, desirable conditions, or courses of action that should be implemented in most situations. The Forest Service can modify guideline direction at the project level, but only after providing rationale for the deviation in the project decision documents and analysis. Individual projects are subject to full analysis and review as prescribed under the National Environmental Policy Act (NEPA) prior to implementation.

Forest Service Manual 2670 describes the agency's policy for evaluating and mitigating effects of projects on TES species. For TES species, this includes identifying the following:

- What TES species exist in the area and could be affected?
- What important habitat for these species exists in the area and might be affected?
- Are there potential adverse impacts to species or habitats, and if so, can they be avoided or mitigated?
- Can specific actions to improve habitat conditions be incorporated into the project?

The Forest Service consults with the US Fish and Wildlife Service, as necessary, if federally-listed threatened or endangered species could be affected, adversely or beneficially, by any aspect of a project. For RFSS, direction contained in agency policy as well as goals, objectives, standards, and guidelines is designed to ensure that when management activities do occur, any effects on RFSS are not likely to result in a trend toward federal listing or a loss of viability on the Forest.

## Chapter 3 - Analysis of Effects, Federally-listed Species

### Conservation Status Ranks

Conservation status ranks identify a species status at several scales (NatureServe 2004a). The status of a species or community is designated by a number from 1 to 5, preceded by a letter denoting the appropriate geographic scale: G for global, N for national, and S for sub-national (state or province). The numbers have the following meaning:

1. critically imperiled,
2. imperiled,
3. vulnerable to extirpation or extinction,
4. apparently secure, and
5. demonstrably widespread, abundant, and secure.

For example, “G1” would indicate that a species is critically imperiled across its entire range (i.e., globally). A rank of “S3” would indicate the species is vulnerable and at moderate risk within a particular state or province, even though it may be more secure elsewhere. “SX” indicates that a species is presumed extirpated from a state or province; “SH” indicates that records are historical, implying possible extirpation; “SA” indicates that occurrence of a species is accidental. Rankings like “S2S3” imply a small degree of uncertainty. “SNR” means the species has not been assessed and is therefore unranked. Qualifiers “B,” “N,” or “M” indicate the status of breeding, non-breeding, and migrant populations. For example, “S2B,S4N” denotes status of “S2” for the species during the breeding season and status of “S4” during the non-breeding season. “T” identifies a particular subspecies; for example, “G5TH” for the eastern cougar identifies a critically-imperiled subspecies of an otherwise widespread and common species.

### Summary of Species Determinations

This Biological Evaluation has determined that the revised Forest Plan and its alternatives will have **No Effect** on the following species:

- Gray wolf (*Canis lupus*)
- Eastern cougar (*Puma [=Felis] concolor cougar*)
- Canada lynx (*Lynx canadensis*)
- Bald eagle (*Haliaeetus leucocephalus*)

The Biological Evaluation has also concluded that the revised Forest Plan and its alternatives **May Affect** but are **Not Likely to Adversely Affect** the following species:

- Indiana bat (*Myotis sodalis*)

In responding to the Forest Service’s Biological Assessment (USDA 1999), the USFWS (2000a) concluded in a letter of consultation that continued implementation of the current Forest Plan should have no effect on the gray wolf, eastern cougar, and bald eagle. Additionally, given no recent or historical records of Canada lynx on the GMNF, and no indication of current or historical habitat for the species on the Forest, the USFWS (2000a) further concluded that implementation of the 1987 Plan was not likely to jeopardize the Canada lynx. In its biological opinion, the USFWS (2000b) concluded that implementation of the Forest Plan was not likely to jeopardize the continued existence of the Indiana bat. The USFWS agreed that the Forest’s standards and guidelines, in conjunction with mitigating measures (retaining snag and roost trees), would significantly reduce the potential for incidental take of Indiana bats.

## Effects Common to All Alternatives

All alternatives promote the protection, enhancement or maintenance of federally-listed species and the habitats on which these species depend. Laws, regulations, and agency policy, all require the Forest Service to maintain viable populations of these species, or to assist in their recovery. While the role that the GMNF plays in contributing to the conservation of these species varies by alternative (for example by providing differing amounts and quality of suitable habitat conditions), all alternatives were developed with the premise that the GMNF will maintain or contribute to the viability and/or recovery of these species, in cooperation with the USFWS.

## Gray wolf

Information presented here on this species is derived from a review of the literature, which is documented in the Forest Plan revision project file referenced in the Bibliography (USFS 2002a, SVE Mammal Panel 2002).

The legal status of the gray wolf in the United States, and the specific taxa to which various degrees of protection have been afforded, have changed several times since the species was first designated as endangered in 1967 (32 FR 4001). The Minnesota population was reclassified as threatened in 1978 (43 FR 9612, USFWS 1992). In 2003, the USFWS established three distinct population segments (DPS) for wolves in the United States: the Western DPS (Washington, Oregon, California, Nevada, Idaho, Montana, Wyoming, northern Utah, and northern Colorado), the Southwestern DPS (Arizona, New Mexico, western Texas and Oklahoma, and southern Utah, and southern Colorado), and the Eastern DPS (North and South Dakota, Nebraska, Kansas, Missouri, Iowa, Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, New York, and New England). A separate DPS for the northeast was considered, but with no firm evidence of an extant wolf population, the region was included in the Eastern DPS. In the wake of recent lawsuits, however, the gray wolf is currently designated as Endangered in the conterminous 48 states except Minnesota (32 FR 4001). The gray wolf is not listed by the State of Vermont (VNNHP 2000). In a letter of consultation dated January 23, 2006, the US Fish and Wildlife Service (2006) confirmed that the gray wolf is listed as endangered and extirpated in Vermont.

### ***Distribution, Status, and Trend***

The gray wolf does not occur on the GMNF, and the GMNF is disjunct from current gray wolf habitat. The gray wolf was extirpated from Vermont and northern New England during the mid- to late 19<sup>th</sup> Century (Godin 1977, DeGraaf and Yamasaki 2001, SVE Mammal Panel 2002).

Gray wolves were historically distributed throughout the northern hemisphere north of 20° N latitude in all habitats and topography except deserts and high mountain tops (Mech 1974). By 1900, the species was extirpated from more than 95 percent of its historic range in the conterminous United States, including New England. In Maine, two animals believed to be wolves were found during the mid-1990s, but no additional confirmed occurrences of wolves in the Northeast are known (65 FR 43449). The known populations closest to the GMNF occur in southeastern Quebec (Harrison and Chapin 1998), Algonquin Provincial Park, Ontario (Theberge et al. 1996), and the north-central United States (USFWS 1992). Wolves that most recently inhabited the northeastern United States have been considered unique among North American wolves; however, it is unclear if northeastern wolves were a subspecies (*C. lupus lycaon*) or a separate species (*C. lycaon*) (Wilson et al. 2000). Hybridization with coyotes in the Northeast has further complicated taxonomy of wolves. Also unclear is whether wolves that occurred in the northeast before European settlers arrived were the same taxon as wolves currently in or within dispersal distance of the region (SVE Mammal Panel 2002, VFWD 2005a).

The gray wolf is ranked by NatureServe (2004b) as G4 globally and N4 in both Canada and the United States, but SX (extirpated) in Vermont. Habitat and population conditions for the gray wolf are not recovering across all portions of its historic range. The status of wolves in the Northeast probably could

not improve over next 20 years without reintroductions, which could only happen if human attitudes toward wolves change. Densities of deer and moose on the GMNF are probably marginal for supporting a viable wolf population (USFS 2002a, SVE Mammal Panel 2002, VFWD 2005a).

### **Life History and Habitat Relationships**

Detailed information on the life history and ecology of the gray wolf is contained in Mech (1974), USFWS (1992), and Paquet and Carbyn (2003).

Availability and sustainability of suitable prey species (e.g., deer, moose, and beaver), prey biomass, and low human density likely have much greater influence on the potential existence of gray wolves in a particular region than any particular forest cover type or vegetation structure (Carbyn 1987, DeGraaf and Yamasaki 2001). Even if white-tailed deer could provide a suitable prey base for wolves in southern and central Vermont, the limited scale of potential habitat and the level of human development may be incompatible with wolves. Viable wolf populations typically require either 10,000 square miles (approximately 6 million acres) of contiguous, suitable habitat if the population is isolated or 5,000 square miles (approximately 3 million acres) of such habitat if the population is within 100 miles of a self-sustaining wolf population (USFWS 1992). Potential dispersal habitat in the northeastern United States would include either forested or mixed forest-cropland cover types with fewer than 16 humans and less than 1.1 miles of roads per square mile (Fuller et al. 1992, Harrison and Chapin 1998). Estimates for core habitat requirements are more rigid, ranging from 2.5 to 6.5 humans and including less than 0.72 miles of roads per square mile of forested habitat (Harrison and Chapin 1998, Mladenoff and Sickley 1998).

### **Limiting Factors and Threats**

The habitat requirements of wolves represent the greatest limiting factor for the species in Vermont and in the Northeast in general. The GMNF probably represents the greatest potential core habitat for wolves in southern and central Vermont (Harrison and Chapin 1998), but other habitat requirements raise doubts as to the likelihood of wolves establishing a viable population in the region. The combination of suitable habitat on a sufficiently-large scale and an adequate food base may not be attainable. Habitat suitability is challenged further by the abundance of highways and the substantial human population (USFS 2002a, SVE Mammal Panel 2002, VFWD 2005a).

In many respects, the ecological niche of the predator on medium-sized or large ungulates that historically was occupied by wolves and cougars has been usurped by coyotes. To become reestablished in the region, wolves would have to overcome competition from coyotes (USFS 2002a, SVE Mammal Panel 2002, VFWD 2005a).

### **Information Gaps**

Given that gray wolves do not exist currently on the GMNF and are not likely to occur on the Forest in the near future, the SVE Mammal Panel (2002 and USFS 2002a) did not identify any information gaps relative to this species and the GMNF Plan revision process.

### **Management Direction Pertinent to Gray Wolf**

The revised Forest Plan makes no specific provisions for management of the gray wolf. Forest-wide goals, objectives, standards, guidelines, and agency policy that conserve threatened and endangered species and their habitats apply to this species (see "Analysis and Management Process" on page 29).

### **Potential Management Effects**

Because of the complete absence of gray wolves on the GMNF, and the questionable suitability of habitats on the Forest, implementation of the revised Forest Plan will have no direct, indirect, or cumulative affect on gray wolves. Further, no aspect of management prescribed in the revised Forest Plan precludes the return of the wolf to the GMNF or in any way diminishes the potential suitability of habitat conditions on the Forest. Core areas of the GMNF will remain largely un-fragmented forest dominated by mature and older northern hardwood forest stands. Fragmentation with roads and

increased levels of human activity represent threats to potential core habitat areas for wolves in most areas. However, the revised Forest Plan does not prescribe any activities that would result in such fragmentation or increased disturbance on the GMNF. The presence of roads and snowmobile trails can increase exposure of wolves to harassment and killing, but they also can facilitate movement of wolves, especially across areas of deep snow. Paquet et al. (1999) expressed uncertainty about the overall influence of roads and snowmobile trails on possible reintroduction of wolves to the Adirondack Park in New York. Such uncertainty is equally appropriate for the possible influence of roads and snowmobile trails on wolves on the GMNF. Further, management under the revised Forest Plan is more likely to enhance the potential habitat for wolves by maintaining and enhancing diversity of habitat and increasing potential diversity and abundance of prey (USFS 2002a, SVE Mammal Panel 2002).

#### **Determination and Rationale**

Because this species is not known to occupy the GMNF, implementation of the revised Forest Plan under any of the alternatives being assessed will have **No Effect** on the gray wolf.

This conclusion is consistent with a consultation held with the USFWS in 2000 regarding continued implementation of the 1987 Forest Plan, and potential effects it might have on endangered, threatened, and proposed species. The USFWS (2000a) concluded that implementation of the 1987 Plan should have **No Effect** on the gray wolf.

### **Eastern Cougar**

Information presented here on this species is derived from a review of the literature, which is documented in the Forest Plan revision project file referenced in the Bibliography (USFS 2002b, SVE Mammal Panel 2002).

The USFWS listed the eastern cougar as endangered in 1973 (38 FR 14678). A recovery plan was completed in 1982 (USFWS 1982). Vermont (VNNHP 2000) lists the cougar (mountain lion) as endangered. In a letter dated September 16, 2004, and confirmed in a second letter dated January 23, 2006, the US Fish and Wildlife Service (2004, 2006) indicated that the eastern cougar is listed as endangered/extirpated in Vermont.

#### **Distribution, Status, and Trend**

The eastern cougar does not occur on the GMNF, and the GMNF is disjunct from current eastern cougar habitat. The cougar was considered extirpated from Vermont since the 1930s, although cougars had not been recorded in the state since 1881 (Godin 1977). In recent years, presence of cougars has been confirmed in Vermont (Bolgiano 1995), Maine (Bolgiano 2000), and New Brunswick, Canada (Cumberland and Dempsey 1994). For these documentations, it was not possible to determine sub-specific designations or whether the cougars were former captive animals (USFS 2002b, SVE Mammal Panel 2002). The Vermont Fish and Wildlife Department (VFWD 2005a: Appendix 4, p. 109) acknowledged that although anecdotal reports of field sightings are fairly frequent, "definitive, tangible evidence" of cougars' presence in Vermont and the Northeast is notably lacking.

The eastern cougar (*Puma* [= *Felis*] *concolor cougar*) is the currently recognized subspecies that was originally known from northeastern North America, and now listed as federally endangered (USFWS 1982). The eastern cougar probably occurred across the Canadian provinces from Nova Scotia to Ontario and southward through the northeastern United States to South Carolina, Tennessee, Kentucky, and Indiana (USFWS 1982). The exact range is unknown because few specimens of certain origin exist. Culver et al. (2000) questioned the taxonomic validity of this subspecies and proposed that all cougars north of Nicaragua belong to a single subspecies (*P.c. cougar*). The USFWS (1990) considered the eastern cougar extinct in the Northeast due to hunting by humans, habitat loss, and low deer populations in the 1800s. Thus, any cougars currently found in the Northeast likely are transients or transplanted individuals from the west (including escaped or released captive animals), rather than representatives of some relict, local population (USFS 2002b, SVE Mammal Panel 2002).



The eastern cougar is ranked by NatureServe (2004b) as G5TH globally and NH in both Canada and the United States. In Vermont, the cougar is unranked (NatureServe 2004b) or known only from historical records (SH) (VNNHP 2000).

### **Life History and Habitat Relationships**

Detailed information on the life history and ecology of the cougar is contained in USFWS (1982), Currier (1983), and Pierce and Bleich (2003).

Cougars have been reported in a wide variety of habitats in the western United States and it would be expected that they would occupy a similar range of diverse habitats in the East. Suitable habitat requires sufficient vegetation to support suitable prey base (probably white-tailed deer in Vermont), but also offer some isolation from human presence. In New England and adjacent areas, this would include remote mountain forests, swamps, and wooded watercourses (DeGraaf and Yamasaki 2001, SVE Mammal Panel 2002, USFS 2002b).

Cougars typically require remote, undisturbed, and un-fragmented habitat on a large scale and an adequate prey base to survive. Beier (1993), using simulated population dynamics, estimated that an area of 1,000 to 2,200 square kilometers (372 to 818 square miles, depending on the demographics of a particular population) was needed for a population of 15-20 adult cougars to have a very low risk (<98%) of extinction within 100 years. Smaller areas might suffice where adequate dispersal corridors allow movement among populations. Cougars typically avoid open areas and areas of human population (Kitchell 1999a), often following watercourses in open areas to remain concealed by bank-side vegetation (Russell 1978). Specific dispersal barriers include roads and nighttime illumination (Beier 1993, 1995). Collisions with motor vehicles are the most common cause of accidental mortality for cougars (Currier 1983, Kitchell 1999a).

### **Limiting Factors and Threats**

The habitat requirements of cougars represent the greatest limiting factor for the species in Vermont and in the Northeast in general. The GMNF probably represents the greatest potential core habitat for cougars in southern and central Vermont, but other habitat requirements raise doubts as to the likelihood of cougars establishing a viable population in the region. The combination of suitable remote, undisturbed, and habitat on a sufficiently-large scale that is un-fragmented by major roads and other forms of human development and an adequate food base may not be attainable (USFS 2002b, SVE Mammal Panel 2002, VFWD 2005a).

It is not clear if the GMNF region could support a suitable prey base, principally white-tailed deer, for a viable population of cougars. In many respects, the ecological niche of the predator on medium-sized or large ungulates historically occupied by cougars and wolves has been usurped by coyotes. To become reestablished in the region, cougars would have to overcome competition from coyotes.

### **Information Gaps**

Given that eastern cougars do not exist currently on the GMNF and are not likely to occur on the Forest in the near future, the SVE Mammal Panel (2002 and USFS 2002b) did not identify any information gaps that had bearing on the GMNF Plan revision process.

The SVE Mammal Panel (2002 and USFS 2002b) did note that the densities of potential prey, moose (*Alces alces*) and white-tailed deer on the GMNF are poorly understood. Accordingly, it is unknown if these populations could support a viable cougar population, or if cougars in the Northeast might be more flexible in their selection of prey than in other regions. Additionally, it is unknown where the closest viable population to the GMNF is located.

### **Management Direction Pertinent to Eastern Cougar**

The revised Forest Plan makes no specific provisions for management of the eastern cougar. Forest-wide goals, objectives, standards, guidelines, and agency policy that conserve threatened and

endangered species and their habitats apply to this species (see “Analysis and Management Process” on page 29).

### **Potential Management Effects**

Cougars have been extirpated from much of their former range, especially in the east. Because of the complete absence of cougars and the apparent lack of suitable habitats on the GMNF, implementation of the revised Forest Plan will have no direct, indirect, or cumulative effects on the species. Further, no aspect of management prescribed in the revised Forest Plan precludes the return of the cougar to the GMNF or in any way diminishes the potential suitability of habitat conditions on the Forest. Core areas of the GMNF will remain largely un-fragmented forest dominated by mature and older northern hardwood forest stands. Fragmentation with roads and increased levels of human activity represent threats to potential core habitat areas for cougars in many areas. However, the revised Forest Plan does not prescribe any activities that would result in such fragmentation or increased disturbance on the GMNF. The presence of roads and snowmobile trails can increase exposure of cougars to harassment and killing, but they also can facilitate movement of cougars, especially across areas of deep snow. Paquet et al. (1999) expressed uncertainty about the overall influence of roads and snowmobile trails on possible reintroduction of wolves the Adirondack Park in New York. Such uncertainty is equally appropriate for the possible influence of roads and snowmobile trails on cougars on the GMNF. Further, management under the revised Forest Plan is more likely to enhance the potential habitat for cougars by maintaining and enhancing diversity of habitat and increasing potential diversity and abundance of prey (USFS 2002b, SVE Mammal Panel 2002).

### **Determination and Rationale**

Because this species is not known to occupy the GMNF, implementation of the revised Forest Plan under any of the alternatives being assessed will have **No Effect** on the eastern cougar.

This conclusion is consistent with a consultation held with the USFWS in 2000 regarding continued implementation of the 1987 Forest Plan, and potential effects it might have on endangered, threatened, and proposed species. The USFWS (2000a) concluded that implementation of the 1987 Plan should have **No Effect** on the eastern cougar.

## **Canada Lynx**

Information presented here on this species is derived from a review of the literature, which is documented in the Forest Plan revision project file referenced in the Bibliography (USFS 2002c, SVE Mammal Panel 2002).

The USFWS designated the Canada Lynx as threatened under the ESA in 14 northern states, including Vermont, in 2000 (65 FR 16051). The Canada lynx is listed as endangered by the State of Vermont (VNNHP 2000). In a letter dated September 16, 2004, and confirmed in a second letter dated January 23, 2006, the US Fish and Wildlife Service (2004, 2006) indicated that the Canada lynx is listed as threatened but not present on the GMNF.

### **Distribution, Status, and Trend**

Canada lynx do not occur on the GMNF, and the GMNF is disjunct from current Canada lynx habitat (USFS 2002c, SVE Mammal Panel 2002, VFWD 2005a). The Forest Service conducted surveys for Canada lynx on the GMNF during September and October of 1999 to 2001 and found no indication of the species on the Forest (Green Mountain National Forest, unpublished data).

Canada lynx are at the southern end of their range in the contiguous United States. Historical lynx occurrence has been verified in 24 northern states south of Alaska (McKelvey et al. 1999), but they currently occur in no more than 6 (68 FR 40075). In the northeastern United States, its range formerly extended into northern Vermont, New Hampshire, and New York, where it was extirpated (USFS 2002c,

SVE Mammal Panel 2002, VFWD 2005a). Lynx have persisted in northwestern Maine, although they are considered rare (Hoving et al. 2003). Habitat for lynx and snowshoe hares in parts of northern New England is contiguous with habitat south of the St. Lawrence River in southeastern Quebec and western New Brunswick. Lynx should encounter little difficulty moving between southeastern Quebec and Maine, northern New Hampshire, and northeastern Vermont because habitat is continuous and without barriers (65 FR 16052).

The Canada lynx is ranked by NatureServe (2004b) as G5 globally, N5 in Canada, N4? in the United States. In Vermont, the lynx is unranked (NatureServe 2004b) or accidental (SA) (VNNHP 2000).

#### **Life History and Habitat Relationships**

Tumlinson (1987), Ruggiero et al. (1999), and Andersen and Lovallo (2003) provide detailed information on life history and ecology of the Canada lynx in the United States and Canada. Habitat for lynx is northern forests and other diverse forest landscapes with significant composition of early successional habitat created by logging, fire, or insect outbreak. Lynx also inhabit swamps, bogs, and rocky areas. Deep winter snow cover favors the large-pawed lynx over the smaller-pawed and shorter-legged bobcat (*Lynx rufus*), and may limit northern expansion of bobcat. Extensive areas of contiguous suitable habitat are needed to ensure viable lynx populations; lynx probably cannot persist in small, isolated refugia of suitable habitat (Ruggiero et al. 1999).

Distribution of lynx is virtually coincident with that of snowshoe hares (Mowat et al. 1999, Aubry et al. 1999). Other species, like red squirrels (*Tamiasciurus hudsonicus*) may serve as secondary prey, but hares dominate lynx' diet even when hares are scarce (Hoving 2001).

#### **Limiting Factors and Threats**

Although the GMNF may represent potentially-suitable core habitat for lynx in southern and central Vermont, lack of connectivity with viable, extant populations of lynx to the north likely precludes return of this species to the GMNF in particular, or to southern and central Vermont, in general (USFS 2002c, SVE Mammal Panel 2002, VFWD 2005a).

Except in areas of deep snow, lynx may be displaced or excluded through competition with bobcats, coyotes, or fishers (*Martes pennanti*), all of which are well established in the GMNF region (Ruggiero et al. 1999, Hoving 2001, SVE Mammal Panel 2002, USFS 2002c, VFWD 2005a). In the next 20 years, bobcats and fishers may become more abundant on the GMNF, particularly if the climate remains warm.

Human presence also is a major limiting factor. This includes disturbances in denning habitat between May and August, as well as activities that result in snow compaction on forest roads and trails that may provide competitors with access into lynx habitat (Ruggiero et al. 1999).

#### **Information Gaps**

Information gaps identified by the SVE Mammal Panel (2002 and USFS 2002c) related to identifying any barriers between the GMNF and core populations of Canada lynx in Maine and in Canada. It is not known if there are significant differences between preferred forest composition of denning habitat for eastern and western lynx populations.

#### **Management Direction Pertinent to Canada Lynx**

The revised Forest Plan makes no specific provisions for management of Canada lynx. Forest-wide goals, objectives, standards, guidelines, and agency policy that conserve threatened and endangered species and their habitats apply to this species (see "Analysis and Management Process" on page 29).

#### **Potential Management Effects**

Because of their current absence on the GMNF and in Vermont, the questionable suitability of habitat on the Forest, and the lack of connectivity to viable habitats or populations in Maine or in Canada, lynx are unlikely to occur on the GMNF. Consequently, implementation of the revised Forest Plan will have no direct, indirect, or cumulative affect on the Canada lynx. Further, no aspect of management prescribed in

the revised Forest Plan precludes the return of the Canada lynx to the GMNF or in any way diminishes the potential suitability of habitat conditions on the Forest. Core areas of the GMNF will remain largely un-fragmented forest dominated by mature and older northern hardwood forest stands. Fragmentation with roads and increased levels of human activity represent threats to potential core habitat areas for lynx in many areas. However, the revised Forest Plan does not prescribe any activities that would result in such fragmentation or increased disturbance on the GMNF. Further, management under the revised Forest Plan is more likely to enhance the potential habitat for Canada lynx by maintaining and enhancing diversity of habitat, particularly through increased availability of early successional habitat in remote areas, thus increasing potential diversity and abundance of prey (USFS 2002c, SVE Mammal Panel 2002).

#### **Determination and Rationale**

Because this species is not known to occupy the GMNF, implementation of the revised Forest Plan under any of the alternatives being assessed will have **No Effect** on the Canada lynx.

The Forest Service consulted with the USFWS in 2000 regarding continued implementation of the 1987 Forest Plan, and potential effects it might have on endangered, threatened, and proposed species. At that time, the USFWS (2000a) concluded that continued implementation of the 1987 Forest Plan was **Not Likely to Jeopardize** the continued existence of the Canada lynx.

### **Indiana Bat**

Information presented here on this species is derived from a review of the literature, which is documented in the Forest Plan revision project file referenced in the Bibliography (USFS 2002d; SVE Mammal Panel 2002, 2003).

The USFWS listed the Indiana bat as endangered in 1967 (32 FR 4001). A recovery plan was completed in 1983 (USFWS 1983). The Indiana bat Recovery Team prepared a "Technical Draft Revised Plan" in October 1996, and the USFWS prepared an "Agency Draft Indiana Bat Revised Recovery Plan" in 1999, but neither document has been incorporated into a final revised plan (USFWS 1999, Clawson 2000). In a letter dated September 16, 2004, and confirmed in a second letter dated January 23, 2006, the US Fish and Wildlife Service (2004, 2006) indicated the Indiana bat is endangered and present on the GMNF. The State of Vermont lists the Indiana bat as endangered (VNNHP 2000).

#### **Distribution, Status, and Trend**

Indiana bats occur primarily in the eastern United States, from Iowa to Vermont, southward to western North Carolina and northern Alabama, and as far west as eastern Oklahoma. Unsubstantiated or isolated records exist for northern Florida, southwestern Alabama, and Michigan (Rommé et al. 1995, BCI 2004a). Distribution records are based primarily on occurrences of hibernating bats (Gardner and Cook 2002). More than half of all known Indiana bats hibernate in seven caves and one abandoned mine in Indiana, Kentucky, and Missouri (Clawson 2002).

In Vermont, Indiana bats probably occur primarily in the Champlain Valley (Sanders et al., *in preparation*), which provides the least forested and warmest conditions in the state (Johnson 1998, Wharton et al. 2003). In its biological opinion and incidental take statement from an earlier consultation, the USFWS (2000b) concluded that Indiana bats are likely to occur on the GMNF, although field observations indicate that such occurrences are limited. Table 3-1 summarizes the numbers of bats captured and identified during survey efforts on and near the GMNF. Of 640 bats captured on or near the Forest from 1999 through 2004, only 26 (4%) have been Indiana bats. Poor weather conditions hampered survey efforts during 2005, and those data are not included. The few bats captured in 2005 included no Indiana bats.

During 2001, 25 Indiana bats were captured during mist net surveys in west-central Vermont (Table 3-1). One of these bats was captured on the western edge of the GMNF near Middlebury, Vermont, representing the first known Indiana bat on the Forest (Kiser et al. 2001). This bat was fitted with a radio

transmitter, and while its transmitter remained active, this bat continued roosting on the Forest (Kiser et al. 2001). The other Indiana bats captured in summer 2001 were in lower-elevation areas of the Champlain Valley (Salisbury and Orwell) west of the GMNF. Two male Indiana bats were captured during late summer/swarming surveys in September 2001 at the Brandon Silver Mine (Kiser et al. 2001). Another Indiana bat was captured within the Proclamation Boundary immediately adjacent to the GMNF near Middlebury during the summer of 2002 (Beverly et al. 2002). No other Indiana bats have been captured or observed on the GMNF during annual summer surveys from 1999 through 2004 (GMNF and Vermont Fish and Wildlife Department, unpublished data). It should be noted that the unidentified *Myotis* bats (*Myotis* spp. in Table 3-1) could have been Indiana bats. The two captured in August 1999 were at the Dorset (Mt. Aeolus) Cave, which is known to be an Indiana bat hibernaculum; the three captured in 2000 escaped before they were identified to species.

**Table 3-1: Numbers of Indiana bats and other species of bats captured during summer surveys on or near the GMNF, 1999 through 2004.**

Species	1999	2000	2001	2002	2003	2004
Indiana bat ( <i>Myotis sodalis</i> )			25	1		
Little brown bat ( <i>Myotis lucifugus</i> )	79	16	135	125	36	54
Northern long-eared bat ( <i>Myotis septentrionalis</i> )	35	19	8	17	7	7
Eastern small-footed bat ( <i>Myotis leibii</i> )				3	1	1
Unidentified <i>Myotis</i>	2	3				
Big brown bat ( <i>Eptesicus fuscus</i> )	9	2	26	11		6
Red bat ( <i>Lasiurus borealis</i> )	1		1	6		
Hoary bat ( <i>Lasiurus cinereus</i> )			2			
Eastern pipistrelle ( <i>Pipistrellus subflavus</i> )			1		1	
Total	126	40	198	163	45	68

Bats typically are censused at hibernacula during winter when they are congregated within confined spaces, relatively inactive, and easy to count. Censuses at hibernacula suggest that Indiana bat populations decreased by 57 percent from 1960 to 2001 across their range. Southern populations, in states from Virginia and Missouri southward, declined 80 percent from 1960 to 2001. Estimated numbers also declined in Pennsylvania, but generally have increased by 30 percent in other northeastern states during the same time (Clawson 2002). It is unknown if local populations are increasing or if these increases are due to emigration from the South and Midwest (USFS 2002d; SVE Mammal Panel 2002, 2003).

Indiana bats do not hibernate on the GMNF, although they are known to use two hibernacula (Dorset Cave and Little Skinner Hollow Cave) within the Proclamation Boundary near Manchester, Vermont, and a third hibernaculum (Brandon Silver Mine) adjacent to the Proclamation Boundary in Brandon, Vermont. In 1999, Indiana bats were reported to be hibernating in a fourth hibernaculum, the abandoned Greely Talc Mine, which is located on the GMNF in Stockbridge, Vermont (USDA 1999). This identification was

later discounted, however, and Indiana bats have not been found at this site since (USDA 2001; Green Mountain National Forest, unpublished data). The three Vermont hibernacula are each rated Priority Three (< 500 Indiana bats) in the Recovery Plan. Priority One hibernacula are those with a recorded population of more than 30,000 bats at some time since 1960; Priority Two hibernacula are/have been occupied by 500 to 30,000 bats since 1960 (USFWS 1999).

The Indiana bat occurred historically in Vermont but had been absent for many years (Trombulak et al. 2001). Resumption of surveys for the species has taken place only recently, after documentation of its recurrence in Vermont and verification of its presence in a hibernaculum. Consequently, there are insufficient data with which to determine recent trends for Vermont, or for northern New England, in general. Therefore, it is not known if the apparent population increase in the Northeast includes Vermont (USFS 2002d; SVE Mammal Panel 2002, 2003). Efforts currently are underway to determine the abundance and distribution of Indiana bats in Vermont, including winter censuses of known caves and abandoned mines that are used by bats as hibernacula. Counts of Indiana bats at the three hibernacula near the GMNF in which Indiana bats have been observed vary from year to year, and no clear trend is apparent (Table 3-2).

Table 3-2: Numbers of bats counted in hibernacula near the GMNF in which Indiana bats have been observed, 1990 through 2005.			
Hibernaculum	Month and year	Number of Indiana bats	Total bats of all species
Brandon Silver Mine	Dec.1992	0 <sup>1</sup>	63 <sup>1</sup>
	Dec.1993	0 <sup>1</sup>	82 <sup>1</sup>
	Feb.1999	0 <sup>1</sup>	135 <sup>1</sup>
	Jan.2002	159 <sup>2</sup>	229 <sup>2</sup>
	Feb.2005	0 <sup>2</sup>	160 <sup>2</sup>
Dorset Cave (Mt. Aeolus)	Jan.1990	8 <sup>1</sup>	1,170 <sup>1</sup>
	Mar.1992	3 <sup>1</sup>	293 <sup>1</sup>
	Jan.1993	3 <sup>1</sup>	309 <sup>1</sup>
	Feb.1994	0 <sup>1</sup>	389 <sup>1</sup>
	Jan.1998	1 <sup>1</sup>	1,040 <sup>1</sup>
	Mar.2003	16 <sup>2</sup>	23,027 <sup>2</sup>
Skinner Hollow and Little Skinner Hollow Caves (combined)	Dec.1998	0 <sup>1</sup>	100 <sup>1</sup>
	Mar.2004	297 <sup>2</sup>	2,004 <sup>2</sup>
<sup>1</sup> Trombulak et al. 2001.			
<sup>2</sup> S. Darling, Vermont Fish and Wildlife Department, unpublished data.			

The Indiana bat is ranked as G2 globally, N2 in the United States, and S1 in Vermont (VNNHP 2000, NatureServe 2004b).

### **Life History and Habitat Relationships**

Detailed information on the life history and ecology of the Indiana bat is contained in Thomson (1982), USFWS (1983, 1999), Rommé et al. (1995), and Kurta and Kennedy (2002). Other general information is available from various sources, including the USFWS (endangered.fws.gov), NatureServe (www.natureserve.org), Bat Conservation International (www.batcon.org), academia, and natural resource agencies of states within the species' range.

Some Indiana bats remain in the same general area throughout the year, migrating as little as 22 miles. Others migrate more than 300 miles between hibernacula and summer feeding and roosting areas (Hall 1962, Belwood 1998). Females leave hibernation sites in late March and April; males leave slightly later (USFWS 1999). Even in the more migratory populations, some males remain in the general vicinity of their hibernaculum throughout the summer (Barbour and Davis 1969). Indiana bats return to the vicinity of their hibernacula from late August through September, swarming at roost sites that typically are within about five miles of the hibernaculum. Mating takes place during this pre-hibernation swarming (Hall 1962, USFWS 2000b, Kiser et al. 2001). The majority of bats are hibernating by late November, earlier in northern areas (USFWS 1999). Indiana bats naturally awaken every 8 to 10 days during the winter, remain active for a short period, then return to torpor (Hall 1962, Thomson 1982, Belwood 1998). Indiana bats usually congregate in large numbers during hibernation, often with other species, including little brown bats (*Myotis lucifugus*), big brown bats (*Eptesicus fuscus*), and northern long-eared bats (*Myotis septentrionalis*) (Kath 2002).

Optimal summer habitat for Indiana bats includes a landscape-level patchwork of open and forested lands, ranging from 20 to 60 percent forest cover, that provides suitable roost trees, sources of flying insects for foraging, and access to open water (Rommé et al. 1995, Farmer et al. 1997, Kurta et al. 2002).

In summer, pregnant females separate from males and non-reproductive females and form maternity colonies. Preferred maternal roost sites are standing trees or snags with loose bark; bats roost under the loose bark, or occasionally in cavities or hollow portions of tree boles and limbs (Gardner et al. 1991a, USFWS 1999). Most roost trees are larger than other available trees with dbh greater than 16 inches (Williams et al. 1993, Rommé et al. 1995, Kurta et al. 2002). Roost trees typically are suitable for only a few years, as exfoliating bark sloughs off and dead trees eventually fall to the ground (Kurta et al. 1995, Clawson 1986, Callahan et al. 1997, Gardner et al. 1991a, Humphrey et al. 1977, Kurta et al. 1993).

In parts of their range, Indiana bats prefer roost trees in the open, along the edge of a forest with an open canopy and open understory, or in or near sources of disturbance (such as residences, roads, livestock operations, timber harvest, etc.), as these sites are exposed to the warming effects of direct sunshine during all or part of the day (USFWS 1999, Kurta et al. 2002). In Vermont, location of maternity roosts may be determined less by open areas or forest edge and more by availability of suitable, large trees (with exfoliating bark, crevices, hollows, etc.) where temperatures are relatively warm (S. Darling, personal communication, May 2005). Maternity colonies typically have one or more primary roosts that receive direct sunlight for much of the day, and alternate roosts in other trees that may be shaded or in the open (Kurta et al. 2002, USFWS 1999). Maternity roost sites are unlikely to be in mature coniferous forest (USFS 2002d; SVE Mammal Panel 2002, 2003).

Males and non-reproductive females seem to spend the summer alone or in small groups in variable habitats. They will use tree roosts (Ford et al. 2002), caves and mines (Handley 1991), and artificial structures (Rommé et al. 1995). Summer roosts of all types are typically within a few hundred meters of open water, especially streams or rivers (Webster et al. 1985, Hofmann 1996, Menzel et al. 2001, Rommé et al. 1995, Kurta et al. 2002).

Indiana bats are insectivorous and have the ability to feed opportunistically on whatever flying insects are prevalent in their foraging habitats (Kurta and Whitaker 1998, USFWS 1999). In some areas, they forage in or beneath the tree canopy, over clearings and farmland, and along forest edges (USFWS 1999, Menzel et al. 2001); in other areas they appear to avoid these areas (Humphrey et al. 1977). Openings and riparian habitat apparently are especially important for foraging habitat in northern New England (Rommé et al. 1995; USFS 2002d; SVE Mammal Panel 2002, 2003). Pre-hibernation swarming habitat also includes a patchwork of open foraging areas and suitable roost trees within about five miles of the hibernaculum (Hall 1962, Kiser et al. 2001).

Very little is known about Indiana bats in Vermont during the non-hibernation period. To date, this species has been found primarily at low elevations in the Lake Champlain Valley (Sanders et al., *in*

*preparation*; Watrous et al., *in press*). Summer roost habitat can be found throughout the GMNF landscape, as an abundance of large trees, both live and dead, exists in all ecological land types. However, temperature may be a key limiting factor. Most of the GMNF is located at higher elevations in the Green and Taconic Mountains where temperatures may be too cool for Indiana bats (SVE Mammal Panel 2002; Sanders et al., *in preparation*; S. Darling, personal communication, June 2004).

Indiana bats exhibit strong site fidelity to hibernacula, as well as to summer colony areas, roosts, and foraging habitat (Hall 1962; Humphrey et al. 1977; Gardner et al. 1991a,b; Callahan et al. 1997).

The degree to which Indiana bats might compete with other sympatric bats for food, foraging areas, or other habitat requirements (e.g., roosting sites) is not known (Husar 1976, Belwood and Fullard 1984).

### **Limiting Factors and Threats**

Access to suitable and secure hibernacula is critical for Indiana bats. The availability of such hibernacula may be a limiting factor in New England and in the northeastern United States in general (USFS 2002d; SVE Mammal Panel 2002, 2003).

Indiana bats may be more tolerant of some disturbance than other bats, but they are still vulnerable, during both hibernation and roosting. Indiana bats do awaken naturally during the winter, but disturbance from human presence can increase the regularity and duration of arousal, which elevates metabolic rates and may cause re-clustering, all of which accelerate depletion of bats' fat reserves (Humphrey 1978). Arousal can result in the loss of enough fat to sustain a bat for 10 to 30 days (Thomas et al. 1990, Thomas 1995). Intense disturbance, including studies by biologists, may result in significantly greater impact to bats than disturbance by passing cavers (Humphrey 1978). Bats roost in areas that are dark and inaccessible to predators and most other animals, but they may abandon roosts if disturbed repeatedly (Belwood 1998). Several instances exist where people purposefully killed large numbers of bats in caves (USFWS 1999).

Indiana bats have low reproductive potential compared to other small mammals. The species' colonial behavior increases the likelihood that disturbance or habitat loss event can impact a large number of bats. These two factors combined mean it can take a long time for their numbers to recover from other threats (USFWS 1999).

Timber harvest can result in negative or beneficial effects to Indiana bat habitat. Some studies indicate that habitat and its use may be affected very little as long as snags and suitable roost trees are protected (USFWS 1999, BCI 2004a). Indiana bats can tolerate some degree of management activity, and limited tree removal may benefit roosts by opening the forest canopy and increasing the warmth of roost trees through insolation (USFWS 1999). Individual bats can be killed, injured, or disturbed when occupied roost trees are cut or disturbed because of activities near their roosts.

Diseases, including rabies, may impact Indiana bat populations, although the incidence of rabies is assumed to be less than one percent (Brass 1994, and references cited therein; Belwood 1998).

Insecticides and pesticides used for agriculture and forestry, especially if applied at dusk, have been implicated in the decline of several bat species. Bats can be killed directly through exposure or through reduced abundance of forage species (Belwood 1998). Heavy metals and other contaminants also can reduce bat populations (Belwood 1998).

Wind turbines used to generate electricity have caused bat mortality in some parts of the United States (Osborn et al. 1997).

Temperature may be a limiting factor for Indiana bats. Much of the GMNF may be too cool (because of elevation) to be suitable for summer roosting and foraging habitat.



**Information Gaps**

Information gaps for Indiana bats stem from limited fundamental knowledge of abundance, distribution, and ecology of the species in Vermont and on the GMNF (USFS 2002d; SVE Mammal Panel 2002, 2003). Are populations increasing in the northeastern United States in general, and in and adjacent to Vermont in particular? If so, at what rates? If Indiana bats do occur on the GMNF during summer, are they maternal colonies or males and non-reproductive females? What and where are preferred roosting and foraging habitats? Which hibernacula are Indiana bats using?

**Management Direction Pertinent to Indiana Bat**

Forest-wide goals, objectives, standards, guidelines, and agency policy emphasize in general the conservation and protection of threatened and endangered species and their habitats (see "Analysis and Management Process" on page 29). The revised Forest Plan also includes management direction specific to the Indiana bat.

The revised Plan identifies those areas on the GMNF in which Indiana bat maternity roosting sites are most likely to occur, based on recent research results (Watrous et al., *in press*) and recommendations of regional bat experts from the US Fish and Wildlife Service and the Vermont Fish and Wildlife Department. These areas are:

- Lands adjacent to the Champlain Valley or in the Valley of Vermont (adjacent to Route 7) that are below 800 feet elevation, and
- Other areas specifically identified by the US Fish and Wildlife Service.

Watrous et al. (*in press*) analyzed Indiana bat roosting habitat in the Champlain Valley of Vermont and New York. Elevation was the most important characteristic associated with roost sites; the mean elevation of roost trees was 110.26 meters with a coefficient of variation of 50.33 meters (362 ± 165 feet). The maximal observed elevation of a roost tree was 204 meters (670 feet). The Forest Service chose to extend potential Indiana bat habitat to 800 feet elevation as a conservative measure. Watrous et al. (*in press*) identify other roost site characteristics (such as, distance to water, tree height, tree bark type, forest canopy closure and type, slope and aspect at the roost site, etc.) that may provide added detail in identifying suitable roosting habitat for Indiana bats. Rather than adopt this greater detail into the revised Forest Plan, the Forest Service applied a more conservative approach in the revised Forest Plan, deferring finer-scale identification of suitable Indiana bat habitat to site-specific analysis for individual projects.

Management actions and protection efforts with respect to Indiana bats on the GMNF focus on two primary components: preventing or minimizing the likelihood of direct impacts to Indiana bats, and conserving potential roosting habitat for Indiana bats in areas where they are likely to occur. The first component is accomplished by restricting removal or damage to potential roost trees or snags within potential Indiana bat maternity roosting habitat, within three miles of a known maternity roost site, and within five miles of known Indiana bat hibernacula when Indiana bats might be roosting in them (from April 15 through October 30), thus preventing death or injury of individual bats. Timber harvest will be allowed within potential Indiana bat maternity roosting habitat or within three miles of a known maternity roosting site from April 15 through October 30 only after adequate surveys have failed to detect the presence of Indiana bats in the proposed project area during the previous two years. Timber harvest within five miles of a known Indiana bat hibernaculum must be in accordance with provisions of a Forest Service management plan for that hibernaculum, which was developed in consultation with the US Fish and Wildlife Service and the Vermont Fish and Wildlife Department. Summer timber harvest will not take place within five miles of a known Indiana bat hibernaculum until such a management plan is in effect. Management activities other than timber harvest within potential Indiana bat maternity roosting habitat from April 15 through October 30 shall not result in the loss or damage of potentially occupied roost trees unless exit-count, ecolocation, or other appropriate surveys indicate to the maximum extent possible that Indiana bats are not present. Conservation and enhancement of potential roosting habitat for Indiana bats is accomplished by insuring the retention of existing, potential, and future roost trees in areas where Indiana bats are likely to occur.

Protection of hibernacula also is critical to viability of Indiana bats. Until the Forest Service acquires land that includes a hibernaculum that houses Indiana bats or Indiana bats are located in another hibernaculum on the GMNF, hibernacula-related management on the GMNF will be limited to habitat management on Forest Service lands within five-miles of known hibernacula. Although there currently are no known Indiana bat hibernacula on the GMNF, all known Indiana bat hibernacula near the GMNF shall be designated as smoke-sensitive areas when planning for prescribed burns to be conducted from October to May. If hibernacula are in the vicinity of the area proposed for burning, factors including wind direction, speed, mixing height, and transport winds shall be considered to avoid, to the maximum extent possible, smoke drifting into or near occupied hibernacula.

Forest Service revised standards and guidelines (S&Gs) for wildlife reserve trees to emphasize retention of uncut patches of trees during even-aged management, to clarify language describing trees and snags to be retained, and to emphasize identification and protection of potential roost trees and potential habitat for Indiana bats. The S&Gs in the amended 1987 Forest Plan, which provide direction for the abundance, density, and distribution of snags, den trees, and nest trees, were derived directly from the Biological Opinion and Incidental Take Statement provided by the USFWS (2000b) with the expressed purpose of reducing possible adverse impacts of forest management activities on Indiana bats. The Forest Service revised these standards and guidelines in consultation with bat experts from the US Forest Service, the US Fish and Wildlife Service, the Vermont Fish and Wildlife Department, and the University of Vermont.

Riparian corridors and openings are important foraging areas for Indiana bats in the northeastern United States (Rommé et al. 1995; SVE Mammal Panel 2002, 2003). Forest-wide management direction from goals, objectives, standards, and guidelines provides substantial protection to riparian areas on the GMNF.

As one of the final steps in the Plan revision process, the Forest Service will consult with the US Fish and Wildlife Service on potential effects that implementation of the revised Forest Plan might have on individuals, populations, and habitat of federally-listed threatened, endangered, and proposed species. This consultation will include thorough evaluation of protections afforded to Indiana bats and potential bat habitat.

This management direction described above applies under all alternatives.

Through cooperative relationships with the US Fish and Wildlife Service, the Vermont Fish and Wildlife Department, other federal and state wildlife agencies, other resource managers, and researchers, the Forest Service will remain involved in conservation and protection efforts and keep abreast of changes in the regional and range-wide status, distribution, and population trends of Indiana bats. The Forest Service will continue to coordinate all efforts related to Indiana bats on the GMNF, including protection, conservation, census, and research, with parallel efforts taking place across the species' range. This high level of communication and coordination increases our knowledge of the status, distribution, ecology, and behavior of Indiana bats, as well as other species of bats, on the GMNF and adjacent lands and contributes to maintenance of an up-to-date, comprehensive knowledge of the status and population trends for the Indiana bat at both regional and range-wide scales. In this way, the Forest Service will be able to respond in a timely manner to any changes in status of Indiana bats on the GMNF and reinstate consultation with the USFWS if and when appropriate. These partnerships and activities are not affected by alternatives.

### **Potential Management Effects**

#### **Direct and Indirect Effects**

Analysis of potential management effects relative to Indiana bats focuses on habitats essential to four major aspects of the species' natural history: summer roosts, summer foraging habitat, roosting and foraging habitat near hibernacula where bats swarm prior to hibernation, and the hibernacula themselves. As described above under *Distribution, Status, and Trend*, except for bats trapped in the vicinity of known

Indiana bat hibernacula, only two Indiana bats have been observed on or immediately adjacent to the GMNF during summer. Indiana bats hibernate in three caves within or adjacent to the GMNF proclamation boundary, but not on the Forest. However, recent information suggests that numbers of Indiana bats in hibernacula in the Northeast are increasing. Other new information indicates that both male and female Indiana bats use a wider range of habitats for roosting and foraging than previously thought. Even though much of the GMNF may be too cool (due to elevation) to provide suitable habitat to Indiana bats, it is prudent to assume that an expanding population in the Northeast may be increasingly likely to occur on the Forest from April through late September, in the lower elevations of the Forest along the Route 7 corridor or within five miles of known hibernacula.

Management activities on the GMNF most likely to affect Indiana bats stem from vegetation or timber management in areas where Indiana bats are likely to occur. Potential adverse effects include direct effects from killing or injuring bats during removal of or damage to an occupied roost tree or snag, or indirect effects from reducing quantity or quality of potential roosting habitat by removing existing or potential roosting trees or snags. Potential beneficial effects include creation of openings or patches in which canopy closure is reduced, thereby enhancing the mosaic of suitable roosting and foraging habitats in close proximity to each other. Specific activities most likely to affect Indiana bats, directly or indirectly, are timber harvest, firewood cutting for commercial or personal use, or creation of permanent upland openings for wildlife habitat or other uses. Other activities, such as management and maintenance of recreational sites, construction and maintenance of roads and trails, removal of hazard trees, wildlife habitat management, prescribed burning, special uses, visual quality management, and protection of cultural resource may alter habitat over smaller areas. Extensive alteration of canopy closure or other forest structure around a hibernaculum can alter temperature, humidity, or other environmental conditions in the hibernaculum, which can in turn affect its suitability.

The removal of some occupied or potential roost trees would be offset to some extent by the fact that roost trees are ephemeral, being suitable for only a limited time because they die, exfoliating bark falls off, and they fall over. New roost trees become available through tree growth and natural mortality (Humphrey et al. 1977, Gardner et al. 1991a, Callahan et al. 1997).

The largest acreage of lands on the GMNF with management concerns relative to Indiana bats are those within five miles of known Indiana bat hibernacula. Of the total land area within these five-mile radii, approximately 20 percent (28,452 acres) are on the GMNF. The relative allocation of these acres to MA that do or do not allow timber harvest or vegetation management varies by alternative (Table 3-3) from the least in Alternative D (12,690 acres, 45%) to the most in Alternative B (19,114 acres, 67%). Of much smaller acreage, but also of potential importance for Indiana bats, are 1,077 acres of GMNF lands adjacent to the Champlain Valley or Valley of Vermont that are at or below 800 feet in elevation. Alternative A allocates slightly less (657 acres, 61%) to MAs that allow timber and vegetation management, compared to 790 acres (73%) for the other alternatives (Table 3-3). The differences between Alternative A and the other alternatives are that timber harvest or vegetation management are not allowed on Newly Acquired Land. All Newly Acquired Land in Alternative A is allocated to MAs that do (Diverse Forest Uses, Green Mountain Escarpment Special Area, and Moosalamoo Recreation and Education Area) or do not (candidate Research Natural Areas) allow timber harvest or vegetation management. Differences between Alternatives B, C, D, and E are in the relative allocation of land to MAs that all allow some timber harvest or vegetation management (Diverse Forest Uses, Green Mountain Escarpment Special Area, and Moosalamoo Recreation and Education Area).

Despite these differences in allocation of land to MAs that do or do not allow timber harvest or vegetation management, differences in direct and indirect effects between alternatives should be negligible. Further, likelihood of direct and indirect effects on Indiana bats as a consequence of management actions conducted under any alternative to the revised Forest Plan will be low to the point of being negligible. This conclusion is based on the limited area of the GMNF on which Indiana bats are likely to occur, the low number of Indiana bats likely to occur on the GMNF, and the protective measures included in the revised Forest Plan to prevent or minimize direct or indirect effects to Indiana bats as a consequence of management actions. As described above (see Management Direction Pertinent to Indiana Bat, above),

Forest-wide standards and guidelines are designed to prevent or minimize (to levels approaching zero) the likelihood of direct impacts to Indiana bats, and to conserve potential roosting habitat for Indiana bats in areas where they are likely to occur. This protection will be accomplished by restricting removal or damage to trees or snags within potential Indiana bat maternity roosting habitat, within three miles of a known maternity roost site, and within five miles of known Indiana bat hibernacula when Indiana bats might be roosting in them, and by insuring the retention of existing, potential, and future roost trees in areas where Indiana bats are likely to occur.

**Table 3-3: Acreage of the GMNF within five miles of bat hibernacula where Indiana bats have been found<sup>1</sup> allocated to MAs that allow different levels of vegetation management activity that could affect Indiana bats or potential Indiana bat habitat, by alternative**

	<b>Alt. A Current Mgt.</b>	<b>Alt. B</b>	<b>Alt. C</b>	<b>Alt. D</b>	<b>Alt. E</b>
	(acres)	(acres)	(acres)	(acres)	(acres)
Acres within 5 miles of hibernacula in MAs allowing vegetation management <sup>2</sup> (% of acres within 5 miles)	14,736 (52%)	19,114 (67%)	16,088 (57%)	12,690 (45%)	13,302 (47%)
Acres within 5 miles of hibernacula in MAs not allowing vegetation management <sup>3</sup> (% of acres within 5 miles)	13,716 (48%)	9,338 (33%)	12,364 (43%)	15,762 (55%)	15,150 (53%)
Total acres within five miles of hibernacula	28,452 (100%)	28,452 (100%)	28,452 (100%)	28,452 (100%)	28,452 (100%)
Acres at or below 800 feet elevation in MAs allowing vegetation management <sup>2</sup> (% of acres ≤ 800 ft. elev.)	657 (61%)	790 (73%)	790 (73%)	790 (73%)	790 (73%)
Acres at or below 800 feet elevation in MAs not allowing vegetation management <sup>3</sup> (% of acres ≤ 800 ft. elev.)	420 (39%)	287 (27%)	287 (27%)	287 (27%)	287 (27%)
Total acres at or below 800 feet elevation	1,077 (100%)	1,077 (100%)	1,077 (100%)	1,077 (100%)	1,077 (100%)

Sources: GMNF GIS Alternative A, B, C, D, and E Management Area Layers.

Notes:

<sup>1</sup> Brandon silver mine, Dorset cave, Skinner Hollow cave.

<sup>2</sup> Diverse Forest Use, Diverse Backcountry, Remote Wildlife Habitat, Green Mountain Escarpment, and Moosalamoo Recreation and Education Area (Alternatives C and E only).

<sup>3</sup> Wilderness, Wilderness Study Area, Remote Backcountry, White Rocks NRA, existing and candidate Research Natural Area, Ecological Special Area, Appalachian Trail, Long Trail, Recreation Special Area, Newly Acquired Land (Alternative A only).

### Cumulative Effects

Through cooperative relationships with the USFWS, the Vermont Fish and Wildlife Department, other federal and State wildlife agencies, other resource managers, and researchers, the Forest Service will remain involved in conservation and protection efforts and keep abreast of changes in the regional and range-wide status, distribution, and population trends of Indiana bats. The Forest Service will continue to coordinate all efforts related to Indiana bats on the GMNF, including protection, conservation, census, and research, with parallel efforts taking place across the species' range. This high level of communication and coordination increases our knowledge of the status, distribution, ecology, and behavior of Indiana bats, as well as other species of bats, on the GMNF and adjacent lands and

contributes to maintenance of an up-to-date, comprehensive knowledge of the status and population trends for the Indiana bat at both regional and range-wide scales. In this way, the Forest Service will be able to respond in a timely manner to any changes in status of Indiana bats on the GMNF and reinstate consultation with the USFWS if, and when, appropriate.

The most likely long-term change relative to Indiana bats, assuming a continuation of current trends, is that the Indiana bat population in the northeastern United States will continue to increase, with a simultaneous expansion of the species onto previously unoccupied but suitable habitat. The Forest Service will revise its definition and identification of areas where Indiana bats are likely to occur as necessary, based on new information, changes in the GMNF land base, or new guidance from the US Fish and Wildlife Service. Examples of new information that could necessitate such changes include the following:

- acquisition of additional lands within five miles of known hibernacula,
- acquisition of additional lands at or below 800 feet in elevation adjacent to the Champlain Valley or Valley of Vermont,
- identification of additional hibernacula inhabited by Indiana bats, or
- new information about the abundance, distribution, habitat use, or general biology of Indiana bats in Vermont.

Management direction, particularly protection measures relevant to Indiana bats, do not vary by alternative. Therefore, differences in cumulative effects between alternatives stems from differences in relative allocation of Forest land into MAs. Within those GMNF lands where Indiana bats are likely to occur, long-term and cumulative effects on Indiana bats should be negligible. Potential adverse effects, either direct or indirect, should be mitigated equally across alternatives by Forest-wide management direction. Potential beneficial effects derived from creation of temporary or permanent openings that enhance the mosaic of suitable roosting and foraging habitats in close proximity to each other do not vary appreciably by alternative. On the Forest-wide scale, long-term differences between alternatives with respect to Indiana bats are diminished by the relatively small acreage on which Indiana bats are likely to occur. Under any of the alternatives, the Forest Service will afford substantial protection to Indiana bats and their habitat. Suitable roosting and foraging habitat will continue to be available on the GMNF.

On a regional scale, the Champlain Valley, to the north and west of the GMNF, represent the most suitable habitat for Indiana bats in Vermont (Sanders et al., *in preparation*). Situated between the Green and Adirondack Mountains, this area has perhaps the mildest climate in Vermont, combined with fertile soils. Accordingly, this area is highly agricultural, including large dairy farms and many acres in pasture, hay, and grain production (Johnson 1998). As a result of these land uses, the Champlain Lowlands has the lowest overall proportional forest cover (about 60%) in Vermont (Wharton et al. 2003). This combination of climate and forest cover means that the Champlain Lowlands currently are within the suitable range of summer roosting and foraging habitat conditions for Indiana bats. During recent decades, proportional forest cover in the Champlain Lowlands has been decreasing (Wharton et al. 2003). The suitability of Indiana bat habitat in this region should remain high unless the area experiences dramatic changes in land use patterns. It is uncertain whether the lower-elevation portions of the GMNF can add significantly to the existing roosting and foraging conditions in the Northeast region.

The importance of GMNF-managed lands probably is greatest relative to hibernacula. Hibernacula used by Indiana bats and other species of bats in the Northeast are naturally-occurring caves and abandoned mines. Hibernacula can be lost in several ways, such as natural cave-ins, being filled in or blocked off for public safety, flooding because of altered water channels or other activities, or reopening of mines. Structural composition of the forested landscape, and the resulting suitability of particular sites for Indiana bats, changes over time. Particular sites can be enhanced or degraded through management activities or natural processes. Caves and abandoned mines do not move, however, and they must be protected where they occur. Management direction relative to Indiana bats will continue to provide protection of hibernacula on the GMNF, and through cooperative efforts, on State and other federally-managed lands. Many hibernacula in the Northeast, however, are located on privately-owned land. Efforts are underway

to secure adequate protection of these hibernacula, but the future security of these sites cannot be guaranteed.

The second important aspect of hibernacula is pre-hibernation swarming that occurs near the hibernaculum. For management purposes, the USFWS (2000b) advises protection of roost trees and other habitat features within a five-mile radius of the hibernaculum. This guidance provides some latitude as to where and how habitat enhancement activities might take place. The locations of the hibernacula are fixed, however, and suitable habitat must be available to support pre-hibernation swarming behavior, which include mating. The effects of increasing maturity and density of forest cover around hibernacula are not addressed in the literature, and the impact of such changes are uncertain beyond the fact that they represent movement away from the range of optimal conditions.

#### **Determination and Rationale**

Implementation of the revised Forest Plan and any of the proposed alternatives **May Affect** but are **Not Likely to Adversely Affect** the Indiana bat. This determination is based on the following:

- the revised Forest Plan includes management direction in standards and guidelines to restricting removal or damage to trees or snags when Indiana bats might be roosting in them, thus preventing or minimizing the likelihood of direct impacts to Indiana bats;
- the revised Forest Plan includes standards and guidelines emphasizing retention of existing, potential, and future roost trees in areas where Indiana bats are likely to occur, thus protecting potential roosting habitat for Indiana bats in areas where they are likely to occur;
- although Indiana bats may be present on the GMNF, they are likely to occur in a limited geographical area, at extremely low density, and the likelihood of incidental take is low to the point of being negligible;
- Best Management Practices and GMNF standards and guidelines that provide direction for management in riparian corridors will protect potential foraging habitat along streams, which are important for Indiana bats in the Northeast;
- upland openings (both natural and managed), wetland openings, roads, and other travel corridors that could serve as foraging areas for Indiana bats will continue to exist on the GMNF, therefore these resources will not be considered limiting; and
- although there currently are no known Indiana bat hibernacula on the GMNF, all known Indiana bat hibernacula near the GMNF shall be considered as smoke-sensitive areas when planning for prescribed burns to be conducted from October to May.

Overall, the likelihood of beneficial effects through creating permanent or temporary openings or by reducing canopy cover in parts of the Forest to enhance roosting and foraging habitat probably is greater than the likelihood of adverse effects or incidental take. Over 13,000 acres of the GMNF lands within five miles of known Indiana bat hibernacula and 790 acres are below 800 feet in elevation along the western side of the GMNF are available for timber harvest and vegetation management activities. [Note: 227 of the 790 acres GMNF lands at or below 800 feet elevation, cited above and in Table 3-3, also are within five miles of hibernacula.] Ongoing cooperative efforts with the Vermont Fish and Wildlife Department, the New York State Department of Environmental Conservation, and the US Fish and Wildlife Service provide avenues for identifying, developing, and conducting habitat enhancement projects in these areas. Protections for Indiana bats in Forest-wide standards and guidelines should eliminate the likelihood of direct effects to bats during any enhancement activities.

### **Bald Eagle**

Information presented here on this species is derived from a review of the literature, which is documented in the Forest Plan revision project file referenced in the Bibliography (USFS 2002e, SVE Bird Panel 2002).

Bald eagles are protected in the United States by the Bald Eagle Protection Act, the Migratory Bird Treaty Act, and the Endangered Species Act (ESA). The USFWS initially listed the bald eagle as endangered in

the 48 conterminous states under the ESA in 1967 (32 FR 4001), down-listed it as threatened in five states but still endangered in the others in 1978 (43 FR 6233), and ultimately as threatened in 48 states in 1995 (60 FR 36010). In a letter dated September 16, 2004, and confirmed in a second letter dated January 23, 2006, the US Fish and Wildlife Service (2004, 2006) indicated that the bald eagle is listed as threatened and present on the GMNF. Vermont lists the bald eagle as endangered (VNNHP 2000).

### **Distribution, Status, and Trend**

Bald eagles are not known to nest on the GMNF. Adult and immature eagles do occur near the GMNF, notably at Somerset Reservoir, and probably forage on the Forest (SVE Bird Panel 2002). Historically, breeding eagles have been rare in Vermont (Fichtel 1985b). Bald eagles have not been known to breed successfully in the state during recent years, although a territorial pair was observed nest-building near the Connecticut River in Bellows Falls in April 2005 (S. Faccio, personal communication, May 2005). Sightings of single adult birds are not uncommon, particularly in the Lake Champlain region during migration or along major river drainages in winter (Fichtel 1985b). In 2004, the Vermont Fish and Wildlife Department, National Wildlife Federation, and several cooperators initiated a program to establish breeding bald eagles in Vermont by "hacking" (a process of gradual release) fledgling birds in the Lake Champlain Basin (NWF 2004).

The bald eagle is widely distributed across Canada and all of the United States except Hawaii. Eagles breed throughout most of this range but generally do not winter in the most northerly areas. Bald eagles breed in New York and all New England states except Vermont, where breeding eagles historically have been rare (Fichtel 1985b), and perhaps Rhode Island. Bald eagles winter in New England along coastal regions, on open inland waters, and along large rivers such as the Connecticut and Merrimack (DeGraaf and Yamasaki 2001, SVE Bird Panel 2002).

Bald eagle populations have fluctuated dramatically in size over the last two centuries. Prior to European settlement of North America, the species was abundant and common across its range, especially where aquatic habitats were abundant. Persecution by humans and the introduction of pesticides led to sharp decreases in eagle populations, and the species became rare in the conterminous United States during the second half of the 20<sup>th</sup> Century. Protection under the Bald Eagle Protection Act (1940), the Endangered Species Protection Act (1966), and the Endangered Species Act of 1973, along with restrictions placed on pesticide use, resulted in population increases (Carroll 1988, Buehler 2000). Bald eagle populations are now stable or increasing most portions of their range (SVE Bird Panel 2002).

The Bald eagle is ranked as G4 globally, N5 in Canada, N4 in the United States, and SHB,S2N (historical records only for breeding, S2 for non-breeding birds) in Vermont (VNNHP 2000, NatureServe 2004c).

### **Life History and Habitat Relationships**

Bald eagles are long-lived birds, living as long as about 30 years in the wild (Buehler 2000) and more than 40 years in captivity (64 FR 36453). Eagles lay eggs from mid-March through mid-May, depending on local conditions. A single brood per year typically includes 2 eggs (SVE Bird Panel 2002). The nestling period lasts 72 to 74 days (DeGraaf and Yamasaki 2001). Young eagles fledge in late July or early August, but as many as half of these birds leave their nests too early, remaining on the ground for weeks before they are capable of flight. Although parents continue to feed them, these grounded birds are more susceptible to predators. The nest remains the focal point for young and adults well into the fall. Young spend progressively less time with adults and begin learning to hunt on their own by trial and error (Buehler 2000). Mortality is high in juveniles, especially during the first year. Gulls (*Larus* spp.), common ravens (*Corvus corax*), American crows (*Corvus brachyrhynchos*), black bears, raccoons (*Procyon lotor*), bobcats (*Lynx rufus*), hawks, and owls are known to prey on eagle eggs, nestlings, and fledglings (Buehler 2000).

Juvenile birds are highly transient during their development, but they may show affinity to particular locations, providing early indications of subsequent breeding areas. Prime nest and perch sites may support generations of use (Evans 1994).

Bald eagles may compete with other raptors [osprey (*Pandion haliaetus*), golden eagle (*Aquila chrysaetos*)] and fish-eating birds (herons, gulls). They also eat carrion, which may result in competition with coyotes, otters, bears, and other mammals (Buehler 2000).

Bald eagles breed along large lakes, river, and estuaries in open areas, forests, and mountains. They commonly use large trees adjacent to water for nesting, perching, and roosting (Peterson 1986, Carroll 1988, DeGraaf and Yamasaki 2001). Distances between nests and shoreline are variable, averaging about 300 feet in Minnesota, 650 feet in Alaska, and 800 feet in Maine. Distances may be greater where there is human activity along the shore (Kozie 1999). Birds show strong attachment to nesting territory and nest sites, but may abandon a nest if human activity around the nest site.

An important characteristic of bald eagle nesting habitat in much of North America is an open forest structure, typically with a canopy closure of less than 40 to 50 percent (Andrew and Mosher 1982, Peterson 1986, Anthony and Isaacs 1989). In the Northeast, however, bald eagles typically select supercanopy white pines as nest trees, therefore canopy closure beneath the nest is of less importance (SVE Bird panel 2002; S. Faccio, personal communication, May 2005). Vegetation around nest site is not important, except that it is generally undisturbed and probably mature (DeGraaf and Yamasaki 2001; SVE Bird Panel 2002).

Territory size varies widely based on nesting density and food supply conditions. Average size was about one square kilometer in Minnesota (Buehler 2000).

Bald eagles winter in coastal regions or on large bodies of open water or where fish or other foods, such as deer carcasses, are available (DeGraaf and Yamasaki 2001).

Connectivity or migratory corridors are not critical for bald eagles, as they are capable of migrating or dispersing over unsuitable habitat, provided that stopover habitat is available. Suitability of stopover sites is more related to food availability than to vegetation characteristics (Beuhler 2002).

### **Limiting Factors and Threats**

Shoreline development and associated loss of nesting, perching, roosting, and foraging habitat is the most significant threat to bald eagles (Buehler 2000).

One 30-year study indicated that most eagle deaths were due to collisions with vehicles, power lines, and other structures (23%), poisoning (16%), gunshot (15%), and electrocution (12%), and (Franson et al. 1995).

Contaminants continue to be a threat to bald eagles. Low reproductive rates have been the biggest obstacle to eagle recovery in Maine; these reproductive problems may be linked to contaminants such as dioxin, mercury, PCB, and DDE (Todd et al. 1982, SVE Bird Panel 2002) DDE (a metabolite of DDT) was responsible for past reproductive failure range-wide, particularly through eggshell thinning. This condition has improved since a ban on DDT was imposed in the 1970's. Other environmental contaminants such as PCBs, organophosphates, and heavy metals (especially mercury) continue to pose threats (Buehler 2000). As predators and scavengers at the top of the food chain, eagles are especially susceptible to bioaccumulation of environmental contaminants (Wiemeyer et al. 1993).

Nest success probably is inversely related to levels of human disturbance. Eagles may abandon nests if human activity occurs nearby (DeGraaf and Yamasaki 2001). Researchers in Washington recommended prohibiting recreational activity during the first five hours of daylight and restricting foot traffic and motorboats within 400 meters of eagle nests (Stalmaster and Kaiser 1998). Bald eagles along the Colorado River in Arizona appeared to prefer reaches of the river with low human activity over those with moderate to high activity (Brown and Stevens 1997).

Declines in abundance or availability of fish, changes in fisheries, or alteration of waterways could negatively impact the prey base of bald eagles (Kozie 1999).



**Information Gaps**

Information gaps relative to bald eagles in Maine, New Hampshire, and Vermont include the minimal size of waterbody and densities of prey necessary to support breeding birds. The maximal distance between nests and foraging habitat in New England are unknown (SVE Bird Panel 2002).

**Management Direction Pertinent to Bald Eagle**

The revised Forest Plan includes standards and guidelines that prohibit controllable disturbance within approximately 330 feet of each eagle nest, except as necessary to protect the nest. Management actions within 660 feet of an eagle nest, or farther away if necessitated by landforms or vegetation conditions, should be designed to conserve or enhance site conditions (for example, structural and compositional integrity). Other Forest-wide direction addresses retention of snags and trees that may be used by wildlife, including bald eagles, for nests, roosts, or dens. Forest-wide goals, objectives, standards, guidelines, and agency policy that conserve threatened and endangered species and their habitats apply to this species (see "Analysis and Management Process" on page 29).

**Potential Management Effects**

Bald eagles are not known to nest on the GMNF, although potentially-suitable nesting habitat occurs on the Forest. Non-breeding and migrant eagles do occur near the Forest and probably forage on the Forest occasionally. Considering this limited use of the Forest by eagles, implementation of the revised Forest Plan will have no direct or indirect effects on the species. The cumulative effect of the Forest Plan on bald eagles, assuming continued adherence to standards and guidelines that protect water quality, maintain soil stability, and retain snags and nest trees, will be continued preservation, maintenance, and enhancement of suitable habitat conditions on the Forest. The suitability of the GMNF for bald eagles likely will increase in the future as trees adjacent to large waterbodies become older, larger, and more suitable for perching and nesting. These changes will not vary by alternative.

**Determination and Rationale**

Implementation of the revised Forest Plan under any of the alternatives being assessed will have **No Effect** on the bald eagle because bald eagles that occur on the GMNF are limited to occasional, transient, non-breeding birds, and the areas adjacent to large waterbodies where they are most likely to occur will not be affected differently by alternatives.

This conclusion is consistent with a consultation held with the USFWS in 2000 regarding continued implementation of the 1987 Forest Plan, and potential effects it might have on endangered, threatened, and proposed species. The USFWS (2000a) concluded that implementation of the 1987 Plan should have **No Effect** on the bald eagle.

## Chapter 4 – Analysis of Effects, Regional Forester Sensitive Animals

### Summary of Species Determinations

After reviewing the proposed action and alternatives, literature, and records, and consulting knowledgeable individuals, the following determinations regarding the Proposed Action and alternatives are made:

The Biological Evaluation has determined that the revised Forest Plan and its alternatives will have **No Impact** on the following species:

- Bicknell's thrush (*Catharus bicknelli*)
- American peregrine falcon (*Falco peregrinus anatum*)
- Common loon (*Gavia immer*)
- Boulder beach tiger beetle (*Cicindela ancocisconensis*)
- Southern pygmy clubtail (*Lanthus vernalis*)
- Harpoon clubtail (*Gomphus desertus*)
- Brook floater (*Alasmodonta varicosa*)
- Creek heelsplitter (*Lasmigona compressa*)

The Biological Evaluation has also concluded that the revised Forest Plan and its alternatives **May Impact Individuals but is Not Likely to Result in a Trend to Federal Listing or Loss of Viability** for the following species:

- Eastern small-footed bat (*Myotis leibii*)
- Wood turtle (*Glyptemys [=Clemmys] insculpta*)
- Jefferson salamander (*Ambystoma jeffersonianum*)
- Forcipate emerald (*Somatochlora forcipata*)
- Gray petaltail (*Tachopteryx thoreyi*)

### Effects Common to All Alternatives

All alternatives promote the protection, enhancement, or maintenance of species of viability concern and the habitats on which these species depend. This level of attention is driven by laws, regulations, and agency policy, all of which require the agency to maintain viable populations. While the role that the GMNF plays in contributing to the conservation of these species varies by alternative (for example, by providing differing amounts and quality of suitable habitat conditions), all alternatives were developed with the premise that viability of these species will be maintained. Where adverse impacts cannot be avoided, management must not result in a trend toward listing of a species under the Endangered Species Act.

The goals, objectives, standards, guidelines, and management area direction described in Chapter 2 applies to development and implementation of management activities on the GMNF. The direction for threatened, endangered, and sensitive species contained within these elements of the revised Forest Plan does not vary by alternative, and so there are no differences in effects on RFSS due to this direction across alternatives.

Direction for protection of RFSS found in agency and departmental policies and regulations sets a high standard for ensuring limited negative effects of management activities on these species. This direction, in combination with goals, objectives, standards, and guidelines, is designed to ensure that when management activities do occur, any effects on species are not likely to result in a trend toward federal listing under the ESA or a loss of viability on the Forest. However, depending on the species of concern, management activities can still have positive or negative effects without resulting in these trends or losses. The effects analyses below for each RFSS detail the impacts that can result from management

activities. Because management activities can be allowed or prohibited depending upon direction associated with each management area, and because management areas are distributed differently across the Forest depending on the alternative, the general level or extent of the effects on each species may also vary by alternative. When this is the case, those differences are also discussed below.

Regional Forester sensitive animal species for the Green Mountain National Forest are listed in Table 4-1, along with the habitat affinities for each species.

**Table 4-1: Regional Forester sensitive animal species and their habitat group affinities**

Species	Alpine and subalpine habitat	Rock and cliff habitat	Barrens or open upland	Aquatic habitat	Shore habitat	Open wetland	Forested wetland	Enriched northern hardwood	Dry and warm forest	Conifer forest	Landscape level species
Eastern small-footed bat		X									X
Bicknell's thrush	X									X	
American peregrine falcon		X									
Common loon				X							
Wood turtle				X	X	X	X	X	X	X	
Jefferson Salamander				X			X	X	X ?		
Brook floater				X							
Creek heelsplitter				X							
Boulder beech tiger beetle					X						
Southern pygmy clubtail					X						
Forcipate emerald						X					
Harpoon clubtail					X						
Gray petaltail							X				

## Eastern Small-footed Bat

Information presented here on this species is derived from a review of the literature, which is documented in the Forest Plan revision project file referenced in the Bibliography (USFS 2002f; SVE Mammal Panel 2002, 2003).

Vermont lists the eastern small-footed bat as threatened (VNNHP 2000).

### **Distribution, Status, and Trend**

During 2002 and 2003, the Forest Service and the Vermont Fish and Wildlife Department (VFWD) captured a total of four eastern small-footed bats on the GMNF during summer census activities (GMNF and VFWD, unpublished data). Small numbers of eastern small-footed bats are known to occupy one hibernaculum on the GMNF and several others within or adjacent to the GMNF proclamation Boundary (USFS 2002f; SVE Mammal Panel 2002, 2003; GMNF and VFWD, unpublished data). Abundance and trends for this species in Vermont are not known (USFS 2002f; SVE Mammal Panel 2002, 2003).

Populations of eastern small-footed bats are small and scattered, occupying an apparently discontinuous range, from the Ozark Mountains of Arkansas, Missouri and Oklahoma, through the Appalachian Mountains northward to southeastern Ontario, and the New England states (Choate et al. 1994, BCI 2004b, NatureServe 2004b). The largest known, contiguous area occupied by the bat is the mountainous areas of New York, Pennsylvania, West Virginia, and Virginia (BCI 2004b, NatureServe 2004a).

The eastern small-footed bat is considered one of the rarest bats in the eastern United States (Robbins et al. 1977), although it may be locally abundant in some areas (Dalton 1987, Handley 1991). Numbers are believed to have declined in recent years, but abundance is extremely difficult to assess or predict due to lack of appropriate survey and monitoring techniques (Erdle and Hobson 2001). About 3,000 individuals are reported from 125 known hibernacula; of these, approximately 60 percent are from two sites in New York State (A. Hicks and C. Butchkoski, personal communications in Erdle and Hobson 2001; NatureServe 2004b), a fact that makes the species vulnerable. Some individual hibernacula have been lost (USFS 2002f; SVE Mammal Panel 2002, 2003).

The eastern small-footed bat is ranked by NatureServe (2004b) as G3 globally, N3 in Canada and the United States, and S1 in Vermont (VNNHP 2000).

### **Life History and Habitat Relationships**

Detailed information on the life history and ecology of the eastern small-footed bat is available from Best and Jennings (1997), NatureServe ([www.natureserve.org](http://www.natureserve.org)), Bat Conservation International ([www.batcon.org](http://www.batcon.org)), academia, and State Agencies. Very few details about the specific biology of this bat are known, particularly for summer. Much of the basic natural history data are from the southern part of the range and may or may not apply in northern New England (USFS 2002f; SVE Mammal Panel 2002, 2003).

Eastern small-footed bats occur in or near deciduous or evergreen forest habitats, particularly in hilly and mountainous areas. Young are born and reared in these communal nursery colonies at maternity roosts that include as many as 20 adult females (Barbour and Davis 1969). Maternity roosts are usually chosen because they are warm or hot, which hastens development of young. Choate et al. (1994) describe this species as “saxicolous,” or “rock-loving” in summer, as small summer maternity colonies have been found under rocks on hillsides and open ridges, in cracks and crevices in rocky outcrops and talus slopes. In parts of their range maternal small-footed bats also roost beneath the bark of dead and dying trees, and in buildings (Webb and Jones 1952, Tuttle 1964, Hitchcock 1965, Barbour and Davis 1969, Handley 1991, Whitaker and Hamilton 1999), but it is not known how prevalent this behavior is in New England. Males roost separately from females, although their precise locations are not known. Males have been captured near the entrances to abandoned mines, caves, railroad tunnels, sandstone rock shelters, cliffs, and trees where they might form small groups or roost singly (Krutzsch 1966, MacGregor and Kiser 1999). There is no evidence to date that eastern small-footed bats colonizes manufactured bat houses.

Eastern small-footed bats hibernate during winter in caves and abandoned or inactive mines at a variety of elevations (Davis et al. 1965, Krutzsch 1966, Barbour and Davis 1969, Dalton 1987). These are hardy bats; they are among the last species to enter hibernacula in the fall and the first to emerge in spring (Barbour and Davis 1969, Gates et al. 1984, Hitchcock et al. 1984). In Vermont and New York, they can enter hibernation as late as November and emerge as early as March. They typically winter segregated from other species, although the same hibernaculum may also include southeastern bats (*Myotis austroriparius*), little brown bats (*M. lucifugus*), northern long-eared bats (*M. septentrionalis*), Indiana bats (*M. sodalis*), big brown bats (*Eptesicus fuscus*), and eastern pipistrelles (*Pipistrellus subflavus*) (Davis et al. 1965, Gates et al. 1984, Hitchcock et al. 1984, Dunn and Hall 1989).

Eastern small-footed bats probably travel only fairly short distances (less 25 miles) between summer habitats and hibernation sites (Hitchcock 1965, Best and Jennings 1997, DeGraaf and Yamasaki 2001). Proximity to water may be an important factor for roosts of males and females (Erdle and Hobson 2001; SVE Mammal Panel 2002, 2003). Eastern small-footed bats have been netted over water, along road

corridors, and near cliff edges (Choate et al. 1994), implying use of various edge habitats for travel and foraging.

Eastern small-footed bats feed on flying insects that are very small relative to their own size. Little detailed information exists on food habits, but these bats have been observed to fly and forage slowly (Barbour and Davis 1969) at and below canopy height, over streams and ponds, and along cliff ledges (Choate et al. 1994). Inter- and intra-specific competition for food has been documented in insect-eating bats (Husar 1976, Belwood and Fullard 1984). The degree to which small-footed bats might compete with other sympatric bats for food, foraging areas, or other habitat requirements (such as roosting sites) is not known, particularly for New England (USFS 2002f; SVE Mammal Panel 2002, 2003).

Predators are likely to include domestic and feral house cats (*Felis silvestris*), raccoons, owls, and snakes that feed opportunistically on bats in trees, buildings, or in cracks and crevices in rocky areas. Swarming and over-wintering bats in caves and mines are susceptible to predators like house cats, opossums (*Didelphis virginiana*), raccoons, and weasels (*Mustela* spp.) (Erdle and Hobson 2001).

Small-footed bats, like all bats, are susceptible to rabies (Constantine 1979, Brass 1994). The incidence of the disease in this species has not been studied but is assumed to be as low as it is in other bats species—probably less than 1 percent (Brass 1994 and references cited therein, Belwood 1998). In New York, big brown bats and little brown bats have fallen victim to West Nile Virus (CDC 2000), which should also be capable of infecting small-footed bats.

#### **Limiting Factors and Threats**

Habitat destruction and/or development (in rural or suburban environments, or for agriculture, road construction, etc.) are likely to negatively affect bats if potential roost sites, snags, and foraging areas (including bodies of water and the insects they produce) are altered. Small-footed bats also may be susceptible to disturbance of rocky cliffs (for example, by rock climbers) where they roost during summer.

Range-wide, forested lands are likely important to the survival of these bats. Forested areas around cave and mine openings may be used for foraging and as roost sites during pre-hibernation swarming behavior. More importantly, forests near cave and mine openings are thought to stabilize humidity and temperature levels inside the cave/mine (Erdle and Hobson 2001).

Bats have very low reproductive rates; their potential for rapid population growth or recovery from population losses is limited. Eastern small-footed bats have smaller populations than other bat species, increasing their risk for population decline or local extirpation at hibernacula or summer roosts (USFS 2002f; SVE Mammal Panel 2002, 2003).

Insecticides and other pesticides (used for agriculture and forestry), which are often applied at dusk to avoid honeybees, have been implicated in the decline of several bat species. These chemicals can kill bats directly if they are sprayed or they can reduce food available to bats. Heavy metals and other contaminants also reduce bat populations (Belwood 1998).

Cavers and other people entering hibernacula can cause bats to arouse and deplete the limited fat reserves necessary for survival during hibernation (Thomas 1995, Thomas et al. 1990) or can intentionally harass or destroy large numbers of hibernating bats. Bats have a low disturbance threshold and may abandon hibernacula if disturbed repeatedly. Whether this concern is as serious for small-footed bats as it is for other species is uncertain since they can use smaller caves, typically hibernate alone or in small groups, and roost in cracks and under rocks instead of on cave ceilings (SVE Mammal Panel 2002, 2003). Roads leading to cave and mine sites can increase the potential for human-related disturbances at hibernacula (USFS 2002f; SVE Mammal Panel 2002, 2003).

Wind turbines used to generate electricity in some parts of the United States have been shown to cause bat mortality (Osborn et al. 1997). Wind turbines near large summer or winter bat roosts, could kill thousands of bats

**Information Gaps**

There is a general lack of information on this species. Continued research will increase our knowledge of basic natural history, including distribution, abundance, and habitat use. Genetic study may provide additional information on population status and trends (USFS 2002f; SVE Mammal Panel 2002, 2003).

The abundance, frequency, and habitat preferences of eastern small-footed bats in the vicinity of the GMNF are unknown. These bats typically roost on the ground, particularly under rocks; however, it is also possible that the species is using other habitat types in the region.

**Management Direction Pertinent to Eastern Small-footed Bat**

There is no species-specific management direction in the revised Forest Plan for the eastern small-footed bat. Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to this species.

Forest-wide standards and guidelines address retention of wildlife reserve trees (snags, den trees, and nest trees), which may be used occasionally by eastern small-footed bats for daytime roosting during the summer. These standards and guidelines provide guidance for the numbers, abundance, and distribution of snags, den trees, and nest trees. This management direction applies under all alternatives.

Cliffs, talus, and other rocky habitats are not specifically protected under revised Forest Plan standards and guidelines, although many of these areas occur in unsuitable lands at higher elevations or in areas protected in various special areas. Site-specific management may become necessary if any of these areas become popular with rock climbers or hikers.

The Forest Service works in close cooperation with the United States Fish and Wildlife Service, the Vermont Fish and Wildlife Department, academic researchers, and through other partnerships to protect and census hibernacula in the region and to increase our knowledge of roosting and foraging ecology of eastern small-footed bats on the GMNF, in Vermont, and in the surrounding region.

**Potential Management Effects****Direct and Indirect Effects**

Potential management effects for bats focus on three fundamental aspects of habitat requirements: winter hibernacula, summer roosting, and foraging. Eastern small-footed bats are known to occupy one hibernaculum on the GMNF. This site is gated and protected from disturbance. Other hibernacula are within or adjacent to the GMNF Proclamation Boundary, but they are not under the jurisdiction of the Forest Service. The Forest Service does work in close cooperation with the United States Fish and Wildlife Service, the Vermont Fish and Wildlife Department, and academic researchers to protect and census hibernacula in the region. Protection at hibernacula is unaffected by alternatives.

To date, no maternity colonies or summer roost sites for eastern small-footed bats are known on the GMNF. Summer survey efforts from 1999 to 2004 have captured four eastern small-footed bats on the GMNF and one on private land adjacent to the Forest (GMNF and Vermont Fish and Wildlife Department, unpublished data).

Bats, including eastern small-footed bats, forage for flying insects in clearings, along forest edges, over water, or under the forest canopy. Permanent and temporary forest openings provide foraging habitat on the GMNF. Less than three percent of the GMNF is in permanent upland or wetland openings (Table 4-2). Upland openings include shrublands and fields that persist naturally or are maintained by cutting brush or with prescribed burning on a regular schedule. Temporary openings currently account for less than one percent of the GMNF (Table 4-3; these are regenerating forest land aged 0-9 years that are created primarily through timber management activities, but also through windthrow, ice storms, flooding, fire, or other "natural" processes. Management activities that create or maintain permanent or temporary forest openings could provide beneficial effects for foraging by bats. These activities include timber harvest,

firewood cutting (commercial or personal use), management and maintenance of recreational sites, construction and maintenance of roads and trails, removal of hazard trees, wildlife habitat management, prescribed burning, special uses, visual quality management, and cultural resource protection.

<b>Table 4-2: Current composition of the GMNF by major forest community</b>		
<b>Forest Community</b>	<b>acres</b>	<b>% of GMNF</b>
Northern hardwood	289,646	76
Mixedwood	39,017	10
Softwood	25,319	7
Aspen-birch	11,531	3
Oak	3,781	1
Upland openings	5,178	1.3%
Wetland openings	5,645	1.4%
Source: Forest GIS data and GMNF FEIS Table 3.5-6.		

<b>Table 4-3: Relative distribution of forest age classes on the GMNF for current conditions and as projected for alternative Forest Plan management at 20 and 150 years</b>				
	<b>Regen.</b>	<b>Young</b>	<b>Mature</b>	<b>Old</b>
	<b>% of GMNF</b>			
Current condition	<1	11	71	18
Projected after 20 years				
Alternative A	5-6	15-16	42-44	35-38
Alternative B	6-7	16-17	42-44	33-35
Alternative C	6-7	15-16	41-43	34-36
Alternative D	5-7	14-15	43-45	34-37
Alternative E	6-7	15-16	42-44	34-36
Projected after 150 years				
Alternative A	5-6	23-26	14-17	51-58
Alternative B	6-7	30-32	15-18	43-49
Alternative C	6-7	28-31	15-18	44-51
Alternative D	5-6	27-30	14-17	47-53
Alternative E	5-6	28-31	15-18	44-51
Source: Forest GIS data and GMNF FEIS Tables 3.5-7 (current) and 3.5-16 through 3.5-20 (projected).				
Notes: These forest communities do not include upland openings, most wetlands, water bodies, or some recently acquired lands for which age-distribution data are not available. For greater detail, see FEIS Section 3.5 Vegetation.				

Although the five alternatives allocate varying proportions of the GMNF to management prescriptions that include timber management and provide varying numbers of suitable acres, differences in the availability of the 0-9 year (regeneration) age class are negligible across alternatives, although each is above the current level (Table 4-3). It should be noted that there is a general background level of natural disturbance (windthrow, ice damage, etc.) that will create between one to three percent of the GMNF in

small patches of the 0-9 year age class that is common to all alternatives (see DEIS Section 3.5 Vegetation).

The five alternatives provide greater differences in the opportunity to create and maintain permanent forest openings. Composition objectives in Chapter 2 of the revised Forest Plan identify a desired range of one to five percent for permanent openings. As described above relative to Indiana bats, Alternatives A and D provide the poorest opportunity for creating new upland openings; the GMNF likely would remain at the lower end of the desired range. Alternative B provides the greatest opportunity for creating new upland openings, and the GMNF should be able to fall at the higher end of the desired range for permanent upland openings. Alternatives C and E provide intermediate opportunity for creating new upland openings, and should keep the GMNF in the middle of the desired range. The relative contribution to foraging habitat for eastern small-footed bats and for other species of bats, and to structural diversity of the Forest in general, would be directly proportional to the amount of forest openings provided, although it is difficult to determine whether this difference in benefit would be measurable.

#### Cumulative Effects

The GMNF is located at the periphery of the range of eastern small-footed bats in the Northeast and in Vermont; the GMNF and the adjacent region are not considered important relative to the species' overall distribution and range-wide status (SVE Mammal Panel 2002, 2003). The cumulative effects of implementing the revised Forest Plan under any of the five alternatives would be continued preservation, maintenance, and enhancement of suitable summer roosting and foraging habitat for the species. Long-term, sustainable management of mixed forested and open lands could contribute to the species' long-term viability in the region.

#### Determination and Rationale

Implementation of the revised Forest Plan and any of the proposed alternatives could affect individual eastern small-footed bats, but management actions prescribed by the Plan are ***Unlikely to Result in a Trend Toward Federal Listing or a Loss of Viability on the GMNF***. This determination is based on the low occurrence of the species near the forest and management direction in the revised Plan, including goals, objectives, standards, and guidelines to protect important habitat for RFSS and to retain potential roost trees.

### **Bicknell's Thrush**

Information presented here on this species is derived from a review of the literature, which is documented in the Forest Plan revision project file referenced in the Bibliography (USFS 2002g, SVE Bird Panel 2002).

Bicknell's thrush is listed among the Regional Forester sensitive species (RFSS) and as a species of special concern by the State of Vermont (VNNHP 2000).

#### Distribution, Status, and Trend

Bicknell's thrush is a specialist that nests in high-elevation (approximately 3,000 feet and higher) conifer-dominated forests within the Green Mountain and White Mountain National Forests (Rimmer et al. 2001b). Although its distribution is patchy overall within the two National Forests, it occurs at fairly high densities in preferred areas of dense, regenerating fir and spruce. Population trends for Vermont are poorly known, due to insufficient baseline data (Rimmer et al. 2001a), but region-wide (New York to Maine) survey data collected from 2001-2004 show Bicknell's Thrush in a four-year decline, averaging - 9.1% per year (Lambert 2005).

Bicknell's Thrush was first described in 1881 by Eugene Bicknell in the Catskill Mountains of New York. Its initial classification was as a subspecies of the gray-cheeked thrush (*Catharus minimus bicknelli*). The American Ornithologists Union (1995) elevated Bicknell's thrush to full species status based on natural history and taxonomic studies by Wallace (1939) and Ouellet (1993).



Bicknell's thrush occupies a limited and fragmented breeding range at higher elevations in New York, Vermont, New Hampshire, Maine, Quebec, New Brunswick, and Nova Scotia (Kibbe 1985; Adamus 1987; Peterson 1988; Richards 1994; Atwood et al. 1996; Rimmer et al. 2001a, 2001b; NatureServe 2004c). Atwood et al. (1996) and Lambert et al. (2005) rank the extent of suitable montane breeding habitat by region in descending order: Adirondack Mountains (New York), White Mountains (New Hampshire), western and central mountains of Maine, Green and Taconic Mountains of Vermont, and Catskill Mountains (New York). Bicknell's thrush is relatively abundant at high elevations within the Green Mountain and White Mountain National Forests (Rimmer et al. 2001b).

The winter distribution of Bicknell's thrush is confined to the Greater Antilles islands in the Caribbean (Rimmer et al. 2001b). Most wintering birds occur in the Dominican Republic, where they are widely distributed from sea level to 7,200 feet (2,220 m) (Rimmer et al. 1999). There are a few records from Haiti, Jamaica, Puerto Rico, and Cuba (Wetmore and Swales 1931, Arendt 1992, Rompré et al. 2000, Rimmer et al. 2005a).

Bicknell's thrush currently is recognized as one of the most at-risk passerine birds in eastern North America. Partners in Flight ranks Bicknell's thrush as the top conservation priority among Nearctic-Neotropical migrant bird species in the Northeast (Rosenberg and Wells 1995, Pashley et al. 2000). Little information exists regarding population trends from any part of species' range, due largely from a lack of population baseline data (Rimmer et al. 2001a). Concern for this species stems from the restricted and highly-fragmented nature of its breeding habitat and from threats of deforestation in the wintering range (Rimmer et al. 2001a).

The Natural Heritage ranks for Bicknell's thrush are G4 globally, N4B in the United States, N3B in Canada, and S3B in Vermont (VNNHP 2000, NatureServe 2004c).

#### **Life History and Habitat Relationships**

Bicknell's thrushes arrive on the breeding grounds in mid- to late May (Rimmer et al. 1996). Known hatching dates in Vermont range from late June to late July; fledging may take place from early July to early August (Rimmer et al. 2001a). Success rates of nests in Vermont vary biennially in response to balsam fir cone production and red squirrel population cycles. During 1994 to 2000, fir cone crops were high in even-numbered years and red squirrel densities were high the following spring and summer, leading to lower nest survival rates for Bicknell's thrushes. The trend reversed during odd-numbered years (Rimmer et al. 2001a).

Migratory patterns of Bicknell's thrush are not well documented, due in part to difficulty in distinguishing this species from the gray-cheeked thrush. Birds leave wintering grounds in late April to early May, arriving in Vermont in mid- to late May. In the fall, most birds have left Vermont by mid-September or early October (Rimmer et al. 2001a).

Few data are available on predators of adult Bicknell's thrushes during the breeding season, although predation by sharp-shinned hawks (*Accipiter striatus*), weasels, and similar predators has been documented (Rimmer and Faccio 2004; Rimmer and McFarland, unpubl. data). The red squirrel is a serious predator of eggs and nestlings; other potential predators include the blue jay (*Cyanocitta cristata*), common raven, eastern chipmunk (*Tamias striatus*), boreal red-backed vole (*Clethrionomys gapperi*), and deer mouse (*Peromyscus maniculatus*) (Wallace 1939, Rimmer et al. 2001a).

Preferred breeding habitat for Bicknell's thrush is high-elevation, spruce-fir forests and sub-alpine krummholz. In the northeastern United States, this habitat is typically located above 3,000 feet (900 m) elevation (Wallace 1939, Atwood et al. 1996, Lambert et al. 2005). This species frequently occurs in highly-disturbed areas that are undergoing succession. Highest densities typically occur in chronically-disturbed locations, such as exposed, high-elevation ridges vegetated with dense, stunted balsam fir, along the edges of human-created openings, or in regenerating balsam fir waves (Rimmer et al. 2001b). Mean canopy height in nesting areas on the White Mountain National Forest was about 15 feet. Most

nests are constructed in balsam fir (live or standing dead) with a mean height of 10 feet and a mean dbh of 2 to 2.5 inches, located in a dense stand of mid-successional fir or krummholz (Wallace 1939, Rimmer et al. 2001a).

This preferred breeding habitat is naturally rare and disjunct in high-elevation “islands,” but vegetation management can be planned to improve habitat or reduce harmful impacts from human activities. Maintenance of low spruce-fir thickets in wide (3-7 m) bands of gradually increasing height along ski trails can provide nesting and foraging sites (Rimmer et al. 2001a, Rimmer et al. 2004). Edge appears to be an important component of this species' habitat. Disturbed areas have small naturally occurring openings (SVE Bird Panel 2002).

### **Limiting Factors and Threats**

The greatest threat to the long-term viability of Bicknell's thrush is loss of the primary broadleaf forests on the wintering range, which are subject to extensive deforestation resulting in widespread habitat loss (Rimmer et al. 2001a, Rimmer et al. 2005a).

Development of high-elevation forests for recreational and commercial uses contributes to reduction and fragmentation of breeding habitat. Alpine and nordic skiing are popular winter sports in breeding habitat of Bicknell's thrush in New York, Vermont, New Hampshire, and Maine. Although Bicknell's thrush appears able to adapt to existing ski areas, little is known about the effects of new ski trail and lift construction on the species (Rimmer et al. 2004). Mountain biking is becoming an increasingly popular recreation in these same habitats during summer. Additionally, habitat features may be degraded by high human presence and use from activities such as hiking. Increased seasonal use of ski areas and potential expansions are of concern (SVE Bird Panel 2002).

Telecommunication towers on mountaintops and development of wind power facilities may further fragment montane breeding habitat and introduce disturbance from construction and servicing activities (Rimmer et al. 2001a, Rimmer and Faccio 2004). Preliminary data suggest that Bicknell's Thrush can tolerate some degree of human disturbance, but more study is needed (Rimmer et al. 2001a). The cumulative effects of these disturbances are unknown.

The possibility of contaminant buildup (for example, atmospheric deposition and bioaccumulation of mercury) and the potential effects on this species and its high elevation habitats are poorly known, but recent studies have shown that thrushes throughout the breeding range exhibit elevated mercury concentrations in their blood and feathers (Rimmer et al. 2005b).

The general decline of high-elevation forests in the United States is well documented (Johnson and Siccama 1983, Eager and Adams 1992). Red spruce dieback can be a severe problem. Balsam fir also is subject to dieback, but fir mortality can be a result of naturally-occurring “fir waves” (Miller-Weeks and Smoronk 1993). Atmospheric deposition (acid rain) may be a factor in this decline (Johnson et al. 1992, NAPAP 1992). Global climate change could also cause major forest reductions in the extent of montane fir forests (Rimmer et al. 2001a, Lambert and McFarland 2004).

### **Information Gaps**

The SVE Bird Panel (2002) and Rimmer et al. (2005c) identified the following information gaps for Bicknell's thrush:

- Robust estimates of overall population size and densities are lacking. Accurate calculations of total population size, based on GIS projections of occupied habitats and spatially-explicit density estimates, are needed throughout the breeding range
- Winter ecology of Bicknell's thrush is poorly understood.
- Breeding ecology is incompletely understood, particularly with respect to relative breeding success in different sub-habitat types.
- The build up of contaminants such as mercury in high elevation areas, and the potential effects on Bicknell's thrush are incompletely known. Similarly, the effects of acid deposition and calcium availability in high-elevation spruce/fir, and the possible synergistic effects of mercury

bioaccumulation and calcium depletion, are not known. Are there impacts of either process on the viability of eggs or on nesting success or on behavior?

- The impacts of hikers, mountain bikers, and dogs on Bicknell's thrushes that nest adjacent to trails are poorly known.

Rimmer et al. (2001a, 2005c) identified the need for focused research and monitoring to address several landscape-level questions:

- How do habitat patches of different size and isolation affect reproductive success, demographics, and site persistence?
- Do the population dynamics of Bicknell's thrush follow a source/sink model?
- What are the patterns of natal dispersal and breeding recruitment?
- Is there population interchange among habitat patches, and if so, how extensive is it?
- What are patterns of natal dispersal and migratory connectivity in Bicknell's thrush?
- What are the causes and demographic/ecological correlates of the species' apparent male-biased breeding sex ratio?
- Can development of a Habitat Suitability Index and its incorporation in a spatially explicit Population Viability Analysis (PVA) be used to develop ecological risk assessments and sound conservation planning for Bicknell's Thrush? A spatially explicit PVA is necessary to better understand how local (development projects at single sites), regional (atmospheric depositions, forest disturbance), and continental (global climate change) perturbations will interact to limit the species' population.
- In addition to better understanding the demographic effects of mercury body burdens in Bicknell's Thrush and possible interactions with calcium depletion and other potential stressors, what is the status of mercury burdens on the species' wintering grounds, where preliminary data show blood concentrations to be up to three times higher than in the Northeast (Rimmer et al. 2005b)?
- What are the potential effects of food availability and its temporal-spatial variability on breeding system structure and reproductive success; diets of adults, nestlings and fledglings; post-fledging dispersal and habitat use; post-breeding movements and habitat use of adults?
- What are the effects of human activities (e.g. recreational development, telecommunications towers, wind turbines) on behavior, spacing patterns, reproductive success, and population persistence over time? Such studies should include both pre- and post-construction phases, and ideally should be replicated in space and time.

### **Management Direction Pertinent to Bicknell's Thrush**

There is no species-specific management direction in the revised Forest Plan for Bicknell's thrush. Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to this species.

The Forest Service works in close cooperation with the United States Fish and Wildlife Service, the Vermont Fish and Wildlife Department, the Vermont Institute of Natural Science (VINS), academic researchers, and through other partnerships to census Bicknell's thrush and other high-elevation migratory birds on the GMNF, in Vermont, and in the surrounding region.

### **Potential Management Effects**

#### **Direct and Indirect Effects**

As described above, the preferred summer habitat for Bicknell's thrush is high-elevation, spruce-fir forests and sub-alpine krummholz. In the northeastern United States and on the GMNF, this habitat is typically located above 3,000 (900 m) elevation (Wallace 1939, Atwood et al. 1996, Lambert et al. 2005). Most of the land in these higher elevations in Vermont is located along the ridgeline of the Green Mountains. Ridgelines and higher elevations are allocated to a mixture of management areas (MAs) in the various alternatives, but land above 2,500 feet in elevation generally is outside of the suitable landbase, meaning it is not subject to commercial timber harvests. On the GMNF, much of this land is within designated Wilderness, the White Rocks National Recreation Area (NRA), Remote Backcountry, and Diverse

Backcountry. Alternatives B through E allocate 706 acres (<1%) into the Alpine/Subalpine special area. Wilderness and Remote Backcountry MAs prohibit any vegetation management beyond trail maintenance. In the White Rocks NRA vegetation management can be conducted for limited purposes, including maintaining habitat conditions for threatened, endangered, or rare species. Thus, under all alternatives, only limited vegetation management is possible within Bicknell's thrush nesting habitat, and alternative-specific differences in effects are negligible.

#### Cumulative Effects

The high-elevation areas of the GMNF and other lands, both public and private, in the Northeast encompass the core breeding range of the Bicknell's thrush (SVE Bird Panel 2002, USFS 2002g). The cumulative effects of implementing the revised Forest Plan under any of the five alternatives will be continued preservation, maintenance, and enhancement of suitable nesting and foraging habitat for Bicknell's thrush on the GMNF. Long-term, sustainable management and protection of this habitat would contribute to the species' long-term viability in the region. These potential cumulative benefits to Bicknell's thrush may be overshadowed by habitat losses off the Forest, particularly in winter habitat in the Caribbean.

#### Determination and Rationale

Implementation of the revised Forest Plan and any of the proposed alternatives will have **No Impact** on Bicknell's thrush. This determination is based on the fact that breeding habitat for the Bicknell's thrush is protected under all five alternatives, and management direction in the revised Plan includes goals, objectives, standards, and guidelines to protect important habitat for RFSS.

### **American Peregrine Falcon**

Information presented here on this species is derived from a review of the literature, which is documented in the Forest Plan revision project file referenced in the Bibliography (USFS 2002h, SVE Bird Panel 2002).

The peregrine falcon is listed among the Regional Forester sensitive species (RFSS). Vermont removed the American peregrine falcon from its list of threatened and endangered species on 23 April 2005 in response to increasing numbers (VFWD 2005b).

#### Distribution, Status, and Trend

During recent years, peregrine falcons have nested in increasing numbers on the GMNF and at numerous other sites in Vermont (Oatman 1985, Fowle et al. 2002). Peregrines disappeared throughout much of the eastern United States by the early 1960s due to pesticide contamination and egg-shell thinning. They were not reestablished in New England until hacking programs (gradual release of reintroduced birds) started at various locations in the late 1970's through the mid-1980's. The first reintroduction effort in Vermont took place in 1977. Natural nesting of these hacked birds began in 1984 in Vermont, and during the late 1980s in Massachusetts and New Hampshire (Oatman 1985, DeGraaf and Yamasaki 2001, Fowle et al. 2002). The State of Vermont recently removed the peregrine falcon from its list of endangered species (VFWD 2005b).

In North America, the peregrine falcon includes three subspecies; *Falco peregrinus tundrius* occurs in the Arctic, *F. p. peali* occurs in the Aleutian Islands, across central and southern Alaska, British Columbia, and Washington State, and *F. p. anatum* occurs from southern Alaska, across Canada, the United States, and northern Mexico. The release throughout eastern North America of thousands of individuals reared from a variety of captive wild stocks has obscured the former boundaries of *F. p. anatum* (Kitchell 1999b, USFS 2002h, SVE Bird Panel 2002).

The USFWS removed the peregrine falcon from its list of endangered species in 1999 (64 FR 46541, August 25, 1999) in response to range-wide recovery of the species, although this decision was not

unanimously accepted by scientists (Pagel et al. 1996, 1998; Pagel and Bell 1997; Cade et al. 1997; Millsap et al. 1998).

The Natural Heritage ranks for the peregrine falcon are G4 globally, N4B,N4N in the United States, N3N,N4B in Canada, and S2B,S2N in Vermont (VNNHP 2000, NatureServe 2004c).

### **Life History and Habitat Relationships**

Detailed information on the life history and ecology of the peregrine falcon is contained in Cade et al. (1988), USFWS (1991), and 64 FR 46541.

Adult peregrine falcons first return to breeding areas in late February or early March. They may visit several potential nesting sites (cliff-hopping) in March and April (Lanier and Bollengier 1994). Egg laying takes place in April or early May in New Hampshire, and in late March through late May in New York. Incubation lasts 28 to 35 days (Lanier and Bollengier 1994, DeGraaf and Yamasaki 2001). At four weeks, chicks become quite active and wander about the nest ledge, exercising their wings. Parents may attack any intruder that comes near the nest area. Adults and fledglings may remain near the aerie until mid- to late August and occasionally until November (Lanier and Bollengier 1994). Age at first flight is 35 to 42 days (DeGraaf and Yamasaki 2001). Mortality rates for adult peregrines apparently are low; individuals may live 18 to 20 years (Kitchell 1999b).

Peregrines prey primarily on small birds, including blue jays, flickers, doves, pigeons, waterfowl, and shorebirds. Rarely or locally, do peregrines prey on small mammals (e.g., bats, lemmings), lizards, fishes, and insects (particularly young birds). Prey pursuit is initiated from perch or while soaring (Lanier and Bollengier 1994, NatureServe 2004c). It is uncertain how far they will travel for food, but it can be greater than 15 miles (Martin 1979, Skaggs et al. 1988). The radii of home ranges in Utah varied from 0.2 to 20 miles (Porter and White 1973).

Predators include the great horned owl, red-tailed hawks, golden eagles, raccoons and coyotes (64 FR 46541).

Preferred nesting habitat includes rocky cliffs with ledges overlooking rivers, streams, lakes, or coastal bays, and where avian prey is abundant. Peregrines occasionally nest on tall buildings in cities here they prey on pigeons and other urban birds (64 FR 46541, DeGraaf and Yamasaki 2001). Common ravens may nest nearby on the same cliff and the two species may use the same aerie in successive years (Lanier and Bollengier 1994).

Populations nesting in northern latitudes are more highly migratory than those nesting at mid-latitudes (Cade 1982). Tundra breeders migrate farthest, bypassing birds that breed farther south (Palmer 1988). The Atlantic Coast of the United States from New Jersey to South Carolina and the barrier islands of the Texas Gulf Coast are important feeding areas for long-distance migrants.

### **Limiting Factors and Threats**

Primary threats to peregrine falcons include human disturbance, raccoon predation, and pesticides and other contaminants (e.g. PCBs, PBDEs) (SVE Bird Panel 2002; S. Faccio, personal communication, May 2005). Predation from great horned owls was a serious threat to hacked falcons in the Mississippi River Valley. Availability of prey may become a future problem (Kitchell 1999b).

Although contamination from pesticides has been reduced in Canada and the United States, peregrines are still exposed to threats of contaminants in Central and South America and Mexico. Pesticide contamination, particularly DDT and related compounds, caused the population decline in the mid-1900s that led to federal endangered status. Threats from other persistent chemical contaminants include PCBs, PBDEs and methyl-mercury.

Threats also include killing by hunters and egg collecting. Pre-fledged birds can be taken from nests for falconry. This practice is tightly controlled in the United States and Canada, but the extent of illegal take is unknown (SVE Bird Panel 2002).

### **Information Gaps**

The SVE Bird Panel (2002) identified the following information gaps:

- The specific characteristics of potential nest sites, including both cliff sites and the surrounding habitat, that make them suitable or preferred are poorly understood.
- The effects of pesticides and the toxicology of other pollutants is not known.

### **Management Direction Pertinent to the American Peregrine Falcon**

The Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to this species. Specific Forest-wide standards and guidelines prohibit potentially disturbing, non-administrative activities within 660 feet of active peregrine falcon nests. Administrative activities designed to conserve or enhance site conditions may occur between 330 and 660 feet of an active nest. All disturbing land uses are prohibited within 330 feet except as necessary to protect the site. These buffer distances may be extended on a case-by-case basis where they are not sufficient because of landform or vegetation conditions.

The Forest Service works in close cooperation with the United States Fish and Wildlife Service, the National Wildlife Federation, the Vermont Fish and Wildlife Department, the Vermont Institute of Natural Science (VINS), and through other partnerships to census and monitor nesting peregrine falcons on the GMNF, in Vermont, and in the surrounding region.

### **Potential Management Effects**

#### **Direct and Indirect Effects**

As described above, the preferred nest sites for the peregrine falcon on the GMNF are rocky cliffs with ledges overlooking rivers, streams, or lakes and where avian prey are abundant. Lands surrounding individual nest sites may be allocated to different management area (MA) prescriptions under different alternatives, but this should have no effect on peregrine falcons. Land above 2,500 feet in elevation generally is outside of the suitable landbase, meaning it is not subject to commercial timber harvests. In addition, most of the suitable nest sites would be allocated to MAs (such as special areas or Remote Backcountry) that restrict vegetation management or other potentially disturbing activities. Most importantly, Forest-wide management direction includes specific protection for active peregrine falcon nests and, as well as protection for habitats important for RFSS in general. These direct and indirect effects do not vary by alternative.

#### **Cumulative Effects**

The high-elevation areas and other potential nesting habitats for the peregrine falcon of the GMNF are at the periphery of the species' range-wide distribution but central to its Vermont distribution (USFS 2002h, SVE Bird Panel 2002). The cumulative effects of implementing the revised Forest Plan under any of the five alternatives will be continued preservation, maintenance, and enhancement of suitable nesting and foraging habitat for the peregrine falcon on the GMNF. Long-term, sustainable management and protection of this habitat would contribute to the species' long-term viability in the region. These potential cumulative benefits to the peregrine falcon will reinforce the general recovery of the species range-wide.

### **Determination and Rationale**

Implementation of the revised Forest Plan and any of the proposed alternatives will have **No Impact** on the peregrine falcon. This determination is based on the fact that nesting sites used by peregrine falcons are protected under all five alternatives, and management direction in the revised Plan includes goals, objectives, standards, and guidelines that specifically protect nesting peregrine falcons and protect important habitat for RFSS in general.

## Common Loon

Information presented here on this species is derived from a review of the literature, which is documented in the Forest Plan revision project file referenced in the Bibliography (USFS 2002i, SVE Bird Panel 2002).

The common loon is listed among the Regional Forester sensitive species (RFSS). Vermont listed the common loon as endangered in 1978 (VNNHP 2000), but the species was removed from the State list of threatened and endangered species in April 2005, in response to increasing numbers and breeding productivity that met goals of the Vermont Loon Recovery Plan (Borden and Rimmer 1998, VFWD 2005b).

### **Distribution, Status, and Trend**

Common loons apparently have never been abundant on the Green Mountain National Forest (USFS 2002i, SVE Bird Panel 2002). For a period of at least 15 years they did not occur on the GMNF, but there has been one nesting pair during recent years. Common loons do nest on many lakes and ponds throughout Vermont. Loons use Somerset Reservoir, which is adjacent to the GMNF, and Lake Champlain in Vermont as staging areas (USFS 2002i, SVE Bird Panel 2002). Populations appear to be increasing and approaching maximal limits in both Vermont and New Hampshire (USFS 2002i, SVE Bird Panel 2002). The State of Vermont removed the common loon from its list of endangered species in April 2005 (VFWD 2005b).

Common loons breed from Alaska across northern Canada to Iceland and southward from California through Montana and the upper Midwest to central Massachusetts. The southern boundary of the breeding range in North America seems to be receding northward relative to the historic condition (Rimmer 1992). Common loons winter along the Atlantic coast from Newfoundland to the Gulf of Mexico. In New England, the common loon breeds throughout Vermont, New Hampshire, and Maine, in central Massachusetts, and perhaps in Connecticut. Wintering birds occur along much of the coastline. The New England region is important to the species as a whole, as the New England population is disjunct from the core range of the species and may be genetically different (DeGraaf and Yamasaki 2001).

In the core of the breeding range, loon populations seem to be stable or increasing (NatureServe 2004c). In New England, at least, the observed population increases from 1969 to 1989 are only relative to decreases during the early to mid-20<sup>th</sup> Century, and numbers in some areas are still below pre-decline levels (McIntyre and Barr 1997).

The Natural Heritage ranks for the common loon are G5 globally, N4B,N5N in the United States, N5B,N5N in Canada, and S2B,S4N in Vermont (VNNHP 2000, NatureServe 2004c).

### **Life History and Habitat Relationships**

Common loons become sexually mature at 4 or more years of age. Immature loons typically stay on the ocean before returning inland to breed. Loons show a high fidelity to nesting areas and often nest near the previous year's nest site. Loons may defend their territories against other loons, large mergansers (*Mergus* spp.) and other large ducks, gulls, beavers (*Castor canadensis*), otters (*Lontra canadensis*), raccoons, coyotes, and snapping turtles (*Chelydra serpentina*) (Richards and Elkins 1994). Eggs are laid from very early June through early August in Maine and New Hampshire and from mid-May through mid-July in New York. Incubation lasts 25 to 33 days. Loons usually raise a single brood of one or two chicks, but they may re-nest after a failed attempt (DeGraaf and Yamasaki 2001). Nestlings are precocious, leaving the nest after one day for nursery areas of shallow water that are protected from strong winds and waves and where small fish or other prey are abundant. Parents defend and carry their young, and may feed them for as long as eight weeks. Most juveniles are capable of flight at 11 to 12 weeks. Adult loons leave their territories when the young birds are 12 to 15 weeks of age. Young loons typically remain on natal lakes another one to three weeks before leaving (Rimmer 1992, McIntyre and Barr 1997). Juveniles become completely independent of their parents between mid-September and mid-November, when they are capable of sustained flight and can catch their own food.

Loons often gather in loose flocks on large lakes before migration, which begins in September and peaks in late October (Richards and Elkins 1994). Northward migration typically begins in April, arriving on freshwater lakes soon after ice-out. Loons migrate singly or in small groups (DeGraaf and Yamasaki 2001). Loons will use inland rivers during migration. Some individuals may over-winter on rivers, but this is weather dependent (Rimmer 1992).

Predators on loon nests include American crows, common ravens, gulls, raccoons, red foxes (*Vulpes vulpes*), mink (*Mustela vison*), weasels, and striped skunk (*Mephitis mephitis*). Primary predators of chicks include snapping turtles, large predatory fish, and gulls. Otters and bald eagles are also occasional predators. Adults have few known predators, although bald eagles and osprey have been observed attacking or harassing loons on breeding grounds (NatureServe 2004c). In wintering grounds, other birds (e.g., grebes, *Podiceps* spp.) may follow loons around feeding areas and raft near them. Gulls occasionally steal food from common loons in marine waters. Of many possible predators in marine habitats, only sea otters have been documented (McIntyre and Barr, 1997).

Intraspecific competition may limit productivity. Sibling aggression can be severe and may result in the death of a subordinate chick. Adult loons may kill chicks that wander into adjacent territories. Severe fighting between adults also has been documented, occasionally leading to death, nest abandonment, or territorial takeover (Rimmer 1992). This phenomenon appears to have become more common in areas where breeding populations and competition for available territories have increased (e.g., Hanson et al. 2004).

The preferred breeding habitat of common loons is small to large oligotrophic, fish-bearing lakes with clear, warm, shallow water, and little or no human disturbance. Lakes are generally surrounded by forest with rocky shorelines, deeply indented bays, numerous islands, and floating bogs (McIntyre and Barr 1997). Minimum lengths of at least ¼ mile are necessary to allow for flight take-off. Breeding has been documented on lakes as small as 10 acres but most often occurs on lakes 50 acres or larger (Rimmer 1992). Loons nest in herbaceous vegetation on islands and along lakeshores (Strong 1985); they will use artificial nest platforms where available (DeGraaf and Yamasaki 2001). Loons may use man-made reservoirs, but water fluctuations typical of these water bodies can lead to nest destruction, predation, or abandonment (DeGraaf and Yamasaki 2001, SVE Bird Panel 2002).

Home ranges vary from 15 to 400 acres per pair. Lakes smaller than 200 acres generally support only single pairs of loons. On larger lakes, territories range from 22 to 415 acres (Rimmer 1992, DeGraaf and Yamasaki, 2001).

Loons use shallow-depth areas for foraging and chick rearing, and deeper water for social interactions (Rimmer 1992). Adult loons tending chicks prefer water less than two meters deep and within 150 meters of land. Adults without chicks tend to forage in water up to four meters deep (Strong, 1985). Clear water to a depth of at least three meters is necessary for successful pursuit of prey (Fichtel 1985a).

Wintering habitat includes inland lakes and rivers that remain unfrozen, as well as coastal marine habitats such as bays, coves, channels, and inlets. Loons will move offshore to waters as much as 100m deep and 100 km from shore if coastal waters are not clear (Rimmer 1992, DeGraaf and Yamasaki 2001).

#### **Limiting Factors and Threats**

Human development of lakeshores is the primary factor limiting the recovery of loon populations. Development often results in the loss or degradation of nesting habitat and water quality, fluctuation of water levels, and an increase in disturbance from human activity (Lee and Arbuckle 1987, DeGraaf and Yamasaki 2001). Hatching success may decline as development increases (Rimmer 1992). Disturbances by canoeists, other boaters, and fishermen can be a serious problem during nesting as it can separate chicks from parents. Wakes from power boats can flood nests (DeGraaf and Yamasaki, 2001). Conversely, loons can generally acclimate to moderate recreational activity (Christenson 1981, NatureServe 2004c).



Lake acidification may affect nesting success, most likely through reduction of prey base (Rimmer 1992), but also through mobilization of heavy metals that are released into the food chain (McIntyre and Barr 1997).

Oil spills and industrial pollutants are potential threats, particularly on wintering habitats (USFS 2002i, SVE Bird Panel 2002). Common loons are susceptible to lead and mercury poisoning, epidemics of types C and E botulism, aspergillosis, internal parasites, and a host-specific black fly (Rimmer 1992, Pokras et al. 1998). Recently, mercury toxicity has been shown to reduce loon breeding productivity through a variety of effects (Evers et al. 2004, Burgess et al. 2005). Since 1984, 15 of 36 dead, recovered adult loons in Vermont have died from lead poisoning and 4 of 36 from complications with fishing hooks and line (Hanson et al. 2004). The Vermont legislature passed a law in May 2004 banning the sale and use of lead sinkers ½ ounce or less, beginning in 2006 and 2007, respectively. Loons occasionally entangle in gill nets and drown (Rimmer 1992). Loons continue to be intentionally killed by sport and commercial fishermen who consider them competition, and loons are still taken as food by some Native American populations (Rimmer 1992).

Low reproductive potential due to delayed sexual maturity and small clutch size can limit population recovery (SVE Bird Panel 2002).

### **Information Gaps**

The greatest information gaps for the common loon are those related to distribution, abundance, and habitat uses of wintering birds (Rimmer 1992, USFS 2002i, SVE Bird Panel 2002). Further research on the potential adverse effects of mercury and other environmental contaminants on loon populations is needed, as is study on the population impacts of intraspecific competition.

### **Management Direction Pertinent to Common Loon**

There is no species-specific management direction in the revised Forest Plan for the common loon. Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to this species. Forest-wide goals, objectives, standards, and guidelines address protection and enhancement of aquatic habitats, which provides benefits to the common loon and its habitat.

The Forest Service annually works in close cooperation with the Vermont Fish and Wildlife Department, the Vermont Institute of Natural Science (VINS), and through other partnerships to monitor loon nesting on the Forest and on adjacent reservoirs, lakes, and ponds and to protect active nests from disturbance. This collaboration should be continued.

### **Potential Management Effects**

#### **Direct and Indirect Effects**

Lakes and ponds potentially suitable for nesting by common loons are protected from lake-shore development, which is the greatest threat to the species in the Northeast. Forest-wide management direction in the revised Plan includes goals, objectives, standards, and guidelines to protect important habitat for RFSS. The Forest Service's active cooperation with partners to monitor and protect common loons will continue. Because these protections are unaffected by alternatives, direct and indirect effects of management on common loons do not change by alternative.

#### **Cumulative Effects**

The GMNF and adjacent lands, both public and private, are at the periphery of the common loon's range-wide distribution but central to its Vermont breeding range (USFS 2002i, SVE Bird Panel 2002). The cumulative effects of implementing the revised Forest Plan under any of the five alternatives will be continued preservation, maintenance, and enhancement of suitable nesting, foraging, and migratory stopover habitat for common loons on the GMNF. Lands managed by the GMNF are protected from lake-shore development, which is the greatest threat to common loons in the Northeast. Long-term, sustainable management and protection of this habitat would contribute to the species' long-term viability.

in the region. These potential cumulative benefits to the common loon will reinforce the general recovery of the species in the Northeast and range-wide.

#### **Determination and Rationale**

Implementation of the revised Forest Plan and any of the proposed alternatives will have **No Impact** on common loons. This determination is based on the fact that nesting, foraging, and migratory stopover habitat for the common loon on the GMNF is protected under all five alternatives, and management direction in the revised Plan includes goals, objectives, standards, and guidelines to protect important habitat for RFSS.

### **Wood Turtle**

Information presented here on this species is derived from a review of the literature, which is documented in the Forest Plan revision project file referenced in the Bibliography (USFS 2002j, SVE Herpetology Panel 2002).

The wood turtle is listed among the Regional Forester sensitive species (RFSS). Vermont lists the wood turtle as a Species of Special Concern (VNNHP 2000).

#### **Distribution, Status, and Trend**

The wood turtle is not abundant on the GMNF. The wood turtle has been reported from twelve of the towns that include or adjoin the southern half of the GMNF and five of the towns along the western and northern boundaries of the northern half of the GMNF (USFS 2002j; SVE Herpetology Panel 2002; J. Andrews, personal communication, July 2005). The wood turtle occurs throughout Vermont, although it is not abundant (VRAA 2004). Population trends in Vermont are not known, but numbers generally are declining across the Northeast, and probably in Vermont, as well (SVE Herpetology Panel 2002, VNNHP 2004).

The wood turtle occurs across Canada from Nova Scotia and New Brunswick, west to Ontario. In the United States it occurs in the Northeast and in the Great Lakes region. The Northeast population extends from Maine to Pennsylvania, south to West Virginia and northern Virginia. In the Great Lakes region, the wood turtle occurs in Michigan, Wisconsin, eastern Minnesota, and northern Iowa (Klemens 1993, Ernst et al. 1994). Northern New England is central to the wood turtles' North American range; therefore its status in these states is important to the overall viability of the species (SVE Herpetology Panel 2002).

The wood turtle has declined throughout its range, largely as a result of past collection for the food market and the pet industry (Klemens 1989, Harding 1990 *cited in* Garber and Burger 1995). Of 13 states in North America that responded to a survey on the status of wood turtles, none reported stable or increasing populations, eight states reported declines, and five states reported unknown trends (NatureServe 2004c). The wood turtle has declined precipitously in southwestern Connecticut and central Massachusetts because of low recruitment and habitat fragmentation (Klemens 1989).

The Natural Heritage ranks for the wood turtle are G4 globally, N4 in the United States, N3 in Canada, and S3 in Vermont (VNNHP 2000, NatureServe 2004c).

#### **Life History and Habitat Relationships**

Farrell and Graham (1991) estimated age at sexual maturity at 14 years in New Jersey; Brooks et al. (1992) reported 17 to 18 years in Ontario. There is no evidence of multiple clutches within a year, and there is some uncertainty whether mature female wood turtles reproduce every year (Ross et al. 1991, USFS 2002j). Because of these factors, the reproductive potential of wood turtles is low.

Breeding is most common in spring and fall (Farrell and Graham 1991, Klemens 1993), but may occur at other times as well (Parren 2001). The breeding season is shorter in colder areas where turtles remain in hibernation for longer periods. Clutch size for wood turtles in northern New England varies from five to 12

eggs (Tuttle and Carroll 1997, Hunter et al. 1999). Nest sites are in sandy-gravelly soil, cutbanks or other eroded banks, and occasionally disturbed sites such as gravel pits, railroad beds, and road grades (Oliver and Bailey 1939, Brooks et al. 1992, Klemens 1993, Buech et al. 1997a, Tuttle and Carroll 1997). Nest sites are sometimes shared with other species of turtles (Harding and Bloomer 1979). Incubation period varies according to environmental factors, especially temperature, ranging from 48 to 71 days (Harding and Bloomer 1979). Gender of hatchling wood turtles is genetically determined, unlike most other species of turtles, which are determined by incubation temperatures (Taylor 1993). Hatchlings emerge from the nest chamber between mid-August and early October (Oliver and Bailey 1939, Ernst et al. 1994). Hatchlings probably do not over-winter in nests (Harding and Bloomer 1979, Klemens 1993, Buech 1995, Ernst 2001b). Little is known about habitat use of hatchling and juvenile wood turtles, but they probably live primarily in aquatic habitats (Harding and Bloomer 1979).

Rates for nest failure generally are high, due to egg predation, or in northern latitudes, from embryonic mortality caused by cool summer temperatures (Brooks et al. 1992). Hatchlings are vulnerable to predation and road mortality while they travel from nest sites to aquatic habitats. Harding (1990) estimated egg and hatchling mortality to be at least 98 percent. Wood turtles depend on high rates of adult survival to compensate for a large mortality in the early stages of life (Arvisais et al. 2002).

Like most other species of turtles, wood turtles are long-lived; ages up to 58 years are recorded for wood turtles in captivity (Oliver 1955 *cited in* Harding and Bloomer 1979). Ages for wild-caught wood turtle range from 20 to 46 years (Klemens 1993, Ernst 2001b). Older age estimates may be conservative as it is difficult to accurately age older individuals (Harding and Bloomer 1979).

The wood turtle uses a variety of aquatic and terrestrial habitats that may vary geographically, as well as among individuals (Kaufmann 1992, Compton et al. 2002). Wood turtles hibernate during the winter, beginning in October or November. Preferred sites for hibernation include undercut banks in slow-moving streams, rivers, and some ponds, as well as, muskrat burrows, root masses along stream edges, and submerged logs. Wood turtles emerge from hibernation in March or April. Summer habitat use varies geographically. In the Midwestern states, wood turtles tend to be largely aquatic, whereas in the eastern portion of the range, wood turtles spend considerable time in upland habitats (Harding and Bloomer 1979, Ernst 1986, Kaufmann 1992, Compton et al. 2002). Wood turtles prefer forest-edge habitat in close proximity (within about 1,000 feet) to permanent streams; these edges provide abundant opportunities for basking and feeding and the dense riparian forbs and shrubs provide important cover (Harding and Bloomer 1979, Carroll and Ehrenfeld 1978, Ernst et al. 1994, DeGraaf and Yamasaki 2001, Compton et al. 2002). They can be found in forest interiors, but it does not appear to be preferred habitat.

Wood turtles are opportunistic omnivores, preferring vegetation and invertebrates: fruits, berries, tender leaves, and mushrooms and other fungi, insects, earthworms, mollusks, tadpoles, or dead fish (Pope 1967; Harding and Bloomer 1979; Strang 1983; Ernst 2001a,b).

Size of home ranges varies among sites and habitat types (USFS 2002j, SVE Herpetology Panel 2002), and probably increases with latitude, ranging from eight acres in Pennsylvania (Kaufmann 1995) to 70 acres in Quebec (Arvisais et al. 2002). In New Hampshire, home ranges averaged 10 acres for females and 14 acres for males (Tuttle and Carroll 1997). Because wood turtles spend much of their time in streams, home ranges are often elongated (Strang 1983). Movement is mostly up and down drainages, as much as two miles a year. Turtles may migrate distances from several hundred feet to over four miles between nesting and hibernation sites (Buech et al. 1997b, Ernst 2001b, Parren 2001, Compton et al. 2002).

Oliver and Bailey (1939) reported wood turtles occurring within an altitudinal range of 140 to 1,155 feet. On the GMNF, wood turtles are probably restricted to below 2,000 feet (SVE Herpetology Panel 2002). This is due primarily to steepness of streams and rivers in headwater areas. The higher elevations typical of much of the GMNF lack the deep, low-gradient streams preferred by wood turtles (Klemens 1993, SVE Herpetology Panel 2002, USFS 2002j).

Predators, particularly raccoons, can kill or mutilate wood turtles (Harding 1990).

Wood turtles are moderately tolerant of some types of habitat alteration such as timber harvesting (Kaufmann 1992), but intense development and high recreational use of habitat can have extremely devastating effects on a population. Two wood turtle populations in Connecticut were extirpated following an increase in recreational activity (Garber and Burger 1995).

### **Limiting Factors and Threats**

All habitat related threats to the wood turtle are human-caused, long-term, on-going, and of both global and local concern. Historically, wood turtle populations were dramatically reduced and fragmented due to collection for food and pets (Harding and Bloomer 1979, USFS 2002j, SVE Herpetology Panel 2002). Both large- and small-scale collections of wood turtles can result in population declines and local extirpations (Hunter et al. 1999). Measures have been taken to reduce this impact, but in areas where development pressure is not great, highway mortality and collection as pets may be the biggest threats to this species (SVE Herpetology Panel 2002; USFS 2002j; S. Faccio, personal communication, May 2005).

Habitat loss, degradation, and fragmentation have contributed to wood turtle declines. This includes urbanization and agricultural activities (Vogelmann 1995, Tuttle and Carroll 1997), as well as alteration of stream channels through stabilization, channelization, and damming (Klemens 1989, Burger and Garber 1995, Buech et al. 1997a, SVE Herpetology Panel 2002, USFS 2002j). These activities can reduce the quality of stream habitats and the availability of suitable nesting sites. Turtles hibernating in the undercut banks of dammed streams can freeze if water flow changes.

Human development can indirectly cause increased exposure to generalist predators, such as raccoons or skunks that may prey on turtle nests, or injure or kill adults (Harding and Bloomer 1979, Farrell and Graham 1991, Brooks et al. 1992, Burger and Garber 1995, Oehler and Litvaitis 1996, Maier et al. 2002).

Primary roads and other intense human developments often act as barriers to turtle movements and increase human access to areas occupied by wood turtles. Automobiles and machinery often result in direct mortality of individuals. Female turtles seeking nest sites are more at risk of being killed on roads than more sedentary males, resulting in a sex bias in some populations and raising questions about population persistence (see Sheen and Gibbs 2004). Road construction causes habitat loss and degradation, increased contact with humans, and direct mortality of both young and adult wood turtles (Brooks et al. 1992). Turtles also become vulnerable as they travel along railroads, where they occasionally become trapped between the tracks (Klemens 1993).

Forest succession can be a threat to turtles if the disturbance regime (natural or through human activity) is inadequate to retain some early successional or shrub habitat. Dense shrubby habitats and nesting sites within riparian areas were maintained historically by flooding. Alteration of stream channels may reduce this natural disturbance. Other human disturbances may create openings and a mosaic of habitats that benefit the wood turtle, but these activities could also be detrimental if they increase fragmentation of habitat, introduce predators, or increase human contact (SVE Herpetology Panel 2002).

Wood turtles are not tolerant of pollution (Harding and Bloomer 1979, DeGraaf and Yamasaki 2001).

As described above, wood turtles have a very low reproductive potential, due to delayed age of sexual maturity, high rates of nest loss, and poor survival of hatchlings. Consequently, any factor that reduces adult survival within populations or removes adults from the population (as pets) will reduce the viability of the species. Additionally, reduced populations have a limited ability to recover.

### **Information Gaps**

Information gaps for the wood turtle relate to basic natural history traits, including abundance and distribution on the GMNF and in the region, and habitat use and dispersal of juveniles (USFS 2002j, SVE Herpetology Panel 2002). Information regarding distribution of this species on the forest would greatly facilitate localized conservation efforts for it (J. Andrews, personal communication, July 2005).

**Management Direction Pertinent to wood turtle**

There is no species-specific management direction in the revised Forest Plan for the wood turtle. Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to this species. In addition, Forest-wide goals, objectives, standards, and guidelines specifically address protection and enhancement of riparian and aquatic habitats.

The Forest Service works in close cooperation with the Vermont Fish and Wildlife Department, the Vermont Institute on Natural Science (VINS), and academic researchers to identify habitats or areas on the GMNF that are important to wood turtles, as well as other reptiles and amphibians.

**Potential Management Effects****Direct and Indirect Effects**

As described above, wood turtles in the Northeast depend on a variety of aquatic and terrestrial habitats. They hibernate in riparian habitat, and although they do occur in upland habitats during summer, they typically stay within about 1,000 feet of permanent streams or small rivers. Forest-wide management direction includes extensive guidance for the protection of riparian habitats, the areas of greatest importance to hatchling and juvenile wood turtles, as well as hibernating adults. This management direction does not vary by alternative.

Wood turtles are moderately tolerant of some types of habitat alteration, such as timber harvesting. In fact, limited timber management can be beneficial to wood turtles by creating or enhancing a mosaic of habitats, including early successional or shrub habitat. The amount of the GMNF allocated to management areas (MAs) that allow timber management, or timber management with some limitations, varies from about 218,000 acres (55%) in Alternative A to about 292,000 acres (73%) in Alternative B (Table 4-4). The amount of suitable land is somewhat less: the least is 157,673 acres (39%) in Alternative A, the most is 216,430 acres (54%) in Alternative B (Table 4-4). Despite these differences in timber management opportunities by alternative, the direct and indirect effects for wood turtles are not likely to vary measurably by alternative. Lands immediately adjacent to riparian habitat are protected from degradation by any management action. The Forest Service will limit activities within 100 feet of wetlands and seasonal pools to those that protect, manage, or improve the condition of those resources. Additionally, many of the riparian habitats of the GMNF likely are too steep to be preferred by wood turtles. Consequently, most wood turtle habitat would be found in areas at moderate to low elevations where streams have a moderate to low gradient. In some cases this is along the margins of the forest where, the GMNF is only providing a portion of the habitat requirements of these populations. For these reasons, if wood turtles do occur on the Forest, they do so in low numbers.

As described above, collection of wood turtles as pets may still be one of the major threats to this species (SVE Herpetology Panel 2002, USFS 2002j). Accordingly, management programs that increase potential exposure of turtles can be of concern. In general terms, Alternatives A and D provide the lowest opportunity for future trail development (Table 4-5), because of the large acreage of Newly Acquired Land in Alternative A and the greatest relative allocation to Wilderness, Wilderness Study Area, and Remote Backcountry in Alternative D. Alternative B offers the greatest opportunity for future trails, primarily because of its large allocation to the Diverse Forest Use MA. However, none of the alternatives specifies a desired level of trail construction over the next 15 years; construction of new trails will be based on demonstrated demand and site-specific analyses. The level of new trail construction is therefore not likely to vary by alternative, although the types of uses may vary.

**Table 4-4: Acres of the GMNF landbase suitable for timber production and acres allocated to MAs that allow varying levels of timber management under the revised Forest Plan, by alternative**

	<b>Alt. A Current Mgt.</b>	<b>Alt. B</b>	<b>Alt. C</b>	<b>Alt. D</b>	<b>Alt. E</b>
	(acres)	(acres)	(acres)	(acres)	(acres)
Suitable acres for timber production	157,673 (39%)	216,430 (54%)	193,791 (48%)	180,381 (45%)	189,616 (47%)
Land allocated to MAs that allow timber and vegetation management <sup>1</sup>	195,410 (49%)	269,605 (67%)	242,188 (60%)	223,006 (56%)	235,592 (59%)
Land allocated to MAs that are not in the suitable land base but allow limited cutting of trees for wildlife habitat <sup>2</sup>	22,758 (6%)	22,758 (6%)	22,758 (6%)	22,758 (6%)	22,758 (6%)
Land allocated to MAs that do not allow timber/ vegetation management <sup>3</sup>	182,524 (45%)	108,329 (27%)	135,746 (34%)	154,928 (39%)	142,342 (35%)

Sources: GMNF GIS Alternative A, B, C, D, and E Management Area Layers, FEIS Timber Management Section (Table 3.13-7) for suitable land acreage.

Notes:

<sup>1</sup> Diverse Forest Use, Diverse Backcountry, Remote Wildlife Habitat, Green Mountain Escarpment, and Moosalamoo Recreation and Education Area (Alternatives C and E only).

<sup>2</sup> White Rocks NRA allows management of wildlife habitat near existing roads.

<sup>3</sup> Remote Backcountry, Wilderness, Wilderness Study Area, existing and candidate Research Natural Area, Ecological Special Area, Alpine/ Subalpine Special Area, Recreation Special Areas, Alpine Ski Areas, Ski Area Expansion, Appalachian Trail, Long Trail, and Newly Acquired Land (Alternative A only).

**Table 4-5: Percent of Green Mountain National Forest Available for Future Trail Development by Trail Use**

<b>Trail Activity</b>	<b>Alt. A</b>	<b>Alt. B</b>	<b>Alt. C</b>	<b>Alt. D</b>	<b>Alt. E</b>
Hike/Foot Travel	77%	97%	99%	89%	92%
Bicycling	58%	77%	72%	58%	66%
Horse/ Pack Animal/ Dog Team	58%	77%	72%	58%	66%
Snowmobile	55%	70%	63%	47%	54%
Summer ORV	49%	64%	54%	41%	45%

Source: FEIS Table 3.10-12 in Recreation Opportunities and Forest Settings.

Differences among alternatives are not likely to represent major differences in potential effects to wood turtles. Alternative B includes “the highest opportunity for motorized and developed recreation” motorized recreation in the spring, summer, and fall (not snowmobiles) and developed recreation could be very detrimental if near Wood Turtle streams. These types of uses should be kept away from known or suspected Wood Turtle habitat. Since Alternative D has “most of the escarpment in a special area” and since the escarpment would include a good portion of this species known or expected habitat, the special attention given to rare species under this alternative could benefit it.

#### Cumulative Effects

The GMNF and adjacent lands, both public and private, are central to the wood turtle’s range-wide distribution in the Northeast. However, many of the streams in the GMNF have too steep a slope for this species, consequently it is most likely concentrated in moderate to low gradient streams in the southern portion of the forest and along the western and northern boundaries of the northern half.

Long-term, sustainable management and protection of this habitat on the Forest would contribute to the species’ long-term viability in the region. These benefits may be overshadowed by habitat losses and continuing population decline off the Forest.

### **Determination and Rationale**

Implementation of the revised Forest Plan and any of the proposed alternatives could affect individual wood turtles, but management actions prescribed by the Plan are ***Unlikely to Result in a Trend Toward Federal Listing or a Loss of Viability on the GMNF***. This determination is based largely on Forest-wide management direction that protects much of the wood turtles' habitat (riparian areas) on the Forest. Additionally, although adult turtles may be affected by management actions in upland habitats adjacent to riparian areas, the likelihood of such effect is small, considering that wood turtles occur on the Forest in low numbers.

### **Jefferson Salamander**

Information presented here on this species is derived from a review of the literature, which is documented in the Forest Plan revision project file referenced in the Bibliography (USFS 2002k, SVE Herpetology Panel 2002).

The Jefferson salamander hybridizes widely with the blue-spotted salamander (*Ambystoma laterale*), making the taxonomy of this species confusing. Hybrids are almost exclusively females, which are unable to reproduce successfully without contribution of male gametes from one of the parent species. Because hybrid populations can not exist alone, it is not valid to define them as separate species. Hybrids may be referred to as *A. laterale x jeffersonianum*.

The Jefferson salamander is listed among the Regional Forester sensitive species (RFSS). Vermont lists the Jefferson salamander as a Species of Special Concern (VNNHP 2000).

### **Distribution, Status, and Trend**

The Jefferson salamander and its associated hybrids occur in the southern two-thirds of Vermont. Although few occurrences are known from the GMNF, the species occurs on all sides of the Forest and within the Proclamation Boundary (SVE Herpetology Panel 2002, VRAA 2004). Vermont and the GMNF are at the northeastern edge of this species' range, and therefore at the periphery of the North American range (USFS 2002k, SVE Herpetology Panel 2002).

"Pure" populations of the Jefferson salamander occur from southern Vermont and New York to western Virginia, central Kentucky, and southern Indiana (Conant and Collins 1998). The zone of hybridization with the blue-spotted salamander is large; hybrids often outnumber pure specimens. Some populations on the east side of the Green Mountains may be pure Jefferson salamanders, although no karyotyping has been done in this area (S. Faccio, personal communication, May 2005). Pure populations of blue-spotted salamanders may be more common than those of Jefferson salamanders. In Maine, New Hampshire, and Vermont there is evidence to suggest that the majority of salamanders with blue spots are hybrids, with more genetic contribution from *A. laterale* than from *A. jeffersonianum* (French and Master 1986, Bogart and Klemens 1997, Hunter et al. 1999, VRAA 2004). Although hybridization may have reduced the numbers and proportions of pure Jefferson salamanders in different populations, it probably has not diminished the species overall geographical distribution (J. Andrews, personal communication, July 2005).

Jefferson salamander is assumed to be declining globally and regionally. This is due to its small range compared to other *Ambystoma* salamanders, continuing reduction of range through hybridization, and apparent sensitivity to habitat fragmentation (SVE Herpetology Panel 2002, USFS 2002k).

The Natural Heritage ranks for the Jefferson Salamander are G4 globally, N4 in the United States, N2 in Canada, and S2 in Vermont (VNNHP 2000, NatureServe 2004c).

**Life History and Habitat Relationships**

It is currently thought that more than one method of reproduction is used by *A. jeffersonianum* and its associated hybrids. There is evidence supporting gynogenesis in hybrids, in which sperm from one of the parental species is required to activate egg development but doesn't contribute to the genetic make-up of the developing embryo (Spolsky et al. 1992). Hybridogenesis apparently also occurs in hybrids, in which the sperm is incorporated, but upon maturity of the offspring, the paternal genome is eliminated in a meiotic or pre-meiotic event (Bogart and Klemens 1997). In pure bisexual diploid populations of *A. jeffersonianum*, reproduction is sexual. A male attracts the attention of a female and deposits a spermatophore, which is picked up by the female and stored in her cloaca. Fertilization is internal, and eggs are laid in elongated clusters attached to underwater sticks and vegetation.

Jefferson salamanders mature at two to five years of age, and they may live an additional six to ten years (MNHP 1989, Taylor 1993, Jackson 1994). Individuals usually breed annually. Females can produce between 100 and 280 eggs in one breeding season, with 12 to 75 eggs in each egg mass. Hybrid females also lay eggs (Jackson 1994, Harding 1997).

Jefferson salamanders breed in discrete, semi-permanent and vernal pools that they may share with several other species of amphibians (Klemens 1993, Harding 1997, Faccio 2003). Migration to breeding pools begins in March and April (Bishop 1941, Bogart 1982, Klemens 1993, Taylor 1993, Brodman 1995), or even late winter (February), while snow still covers much of the ground (DeGraaf and Yamasaki 2001). A day or two of warm rain or rapid snow melt apparently triggers the spring migration (Harding 1997). After breeding, adult Jefferson salamanders migrate back to forested upland sites, where they spend much of the summer underground.

Incubation time varies from two weeks to 45 days, depending on water temperature (Harding 1997). Larvae usually metamorphose in late summer, within two to three months of hatching (Bishop 1941, Harding 1997, Klemens 1993). Larvae can metamorphose faster if a breeding pond dries up early, but the adults may be smaller (Brodman 1996, Harding 1997). Newly-metamorphosed Jefferson salamanders disperse into surrounding wooded areas from breeding ponds, typically within 800 or 900 feet. They hide beneath leaf litter, under stones, in subterranean burrows, or in decomposing logs and stumps (DeGraaf and Yamasaki 2001, SVE Herpetology Panel 2002).

Hatching success and larval survival typically are low, mostly due to predation (Klemens 1993, Harding 1997). Larvae are especially vulnerable to fish predation (SVE Herpetology Panel 2002). One mark-recapture study estimated about 50 percent survival during the first year, about 25 percent through two years, and 10 percent after three years (Pfingsten and Downs 1989). Survival of larvae also may vary with water chemistry, temperature, and hydroperiod (Freda 1986, Rowe and Dunson 1993, Brodman 1995, Brodman 1996).

Jefferson salamanders have many potential predators. Aquatic insects (e.g., dragonfly nymphs), turtles, fish, and newts can prey on larval salamanders in aquatic habitats (Thompson et al. 1980). Birds, snakes, small mammals, large spiders, and raccoons are potential threats on land. Several species whose populations have been increased due to human populations, notably turkeys, crows, and raccoons, also pose a threat as predators (SVE Herpetology Panel 2002, USFS 2002k).

Jefferson salamanders require both wetland and terrestrial habitats within dispersal distance of each other to complete their life cycle. Preferred terrestrial habitat is moist, well-drained, upland hardwood or mixed forests; Jefferson salamanders usually avoid lowland areas prone to flooding (Taylor 1993, Harding 1997). Jefferson salamanders occasionally occur in hemlock forests or in mixed northern hardwood-hemlock stands, but in general, conifer forests typically are too acidic and dry (Klemens 1993; SVE Herpetology Panel 2002; S. Faccio, personal communication, May 2005).

As adults, Jefferson salamanders spend much of the non-breeding season under or within rotting logs, under rocks, buried in leaf litter, or underground in small mammal burrows (MNHP 1989, Klemens 1993, Taylor 1993, SVE Herpetology Panel 2002, Faccio 2003). Jefferson salamanders are less tolerant of



open habitats and habitat disturbance, and use more upland habitat, than their close relatives, the blue-spotted salamanders (Pfingsten and Downs 1989, Klemens 1993, Bogart and Klemens 1997, Harding 1997, deMaynadier and Hunter 1998).

Jefferson salamanders breed in vernal or semi-permanent pools, which are within or adjacent to their woodland habitat. These typically are discrete pools with little or no water movement, located in rocky, moderately- to steeply-graded, forested areas. It is important that these pools retain water into mid-summer and are not inhabited by fish (Rowe and Dunson 1993, Klemens 1993, Harding 1997). The Jefferson salamander prefers breeding pools that are surrounded by undisturbed forests. On the GMNF, this species is most often found at low elevations (below 1,200 ft.) on the margins of the Forest (J. Andrews, personal communication, July 2005).

Jefferson Salamanders can migrate up to a mile from their breeding habitat, although average dispersal distances are a quarter mile or less (numerous references cited in Semlitsch 1981, 1998; Faccio 2003). Newly-metamorphosed Jefferson salamanders disperse into surrounding wooded areas from breeding ponds, typically within 800 or 900 feet. Because of these migrations, management must take into consideration activities and their effects on upland areas adjacent to breeding areas to maintain viable populations (SVE Herpetology Panel 2002). Roads and forest edges present potential barriers to dispersal. Salamanders can be particularly sensitive to the effects of recent forest management practices. A 40-foot-wide, heavily-used logging road can be sufficient to inhibit movement of salamanders (deMaynadier and Hunter 1998, 2000). Pfingsten and Downs (1989) suggested that the Jefferson salamander is more sensitive to open habitats than the blue-spotted salamander.

Descriptions of the elevation range in which Jefferson salamanders occur are confounded by the genetic uncertainties between Jefferson and blue-spotted salamanders. Recent studies in New England have observed Jefferson salamanders at elevations between 1,000 and 1,700 feet (Klemens 1993, SVE Herpetology Panel 2002, Faccio 2003).

Jefferson salamanders apparently avoid strongly acidic soils and water. Laboratory experiments demonstrated that low pH in the field exacerbated water loss in metamorphs, and decreased sodium (Na) levels in the body which interferes with retention of body water. Embryonic and larval survival and the number of egg masses laid in ponds may be reduced by low pH (Horne and Dunson 1994a, Rowe et al. 1992, Rowe and Dunson 1993). Low pH also may increase the solubility and toxicity of aluminum. Within a very small pH range, aluminum may have beneficial effects on embryonic survival, but under more acid conditions, aluminum becomes toxic to salamander embryos (Horne and Dunson 1994b). The cause of pool acidification is unclear, but acid precipitation has been discussed as a probable cause (Cook 1983, Pierce 1985, Freda 1986). In New Hampshire and Vermont, they are usually found in fairly neutral ponds (SVE Herpetology Panel 2002).

### **Limiting Factors and Threats**

Jefferson salamanders require a mosaic of wetland and forested habitats. Loss of either habitat type represents a major threat to the species, particularly the loss of breeding ponds. Activities that affect the persistence of breeding pools, or that introduce fish or other predators also degrade habitat quality (USFS 2002k, SVE Herpetology Panel 2002).

Fragmentation also can reduce the overall quality of remaining habitats and isolate populations. Roads represent a threat of direct mortality to migrating salamanders, from automobiles or all-terrain vehicles. Overall abundance of salamanders also may be lower near roads (Klemens 1993, Lehtinen et al. 1999, deMaynadier and Hunter 2000, USFS 2002k, SVE Herpetology Panel 2002).

Declining pH of breeding pools (due to human or natural causes) could also lower suitability of habitat and could threaten local populations (Sadinski and Dunson 1992).

Many areas and management organizations protect wetlands; however, small vernal pools, such as those used by Jefferson salamanders, can be overlooked in the dry season, or receive little or no protection

(Jackson 1994, Hunter et al. 1999). Even if pools are identified and protected, the area of protection may not extend far enough into the surrounding land (Semlitsch 1998).

Hybridization also represents a serious threat to the Jefferson salamander. The Jefferson genotype is quite abundant in the Northeast, but mostly in hybrids (Bogart and Klemens 1997). Ultimately, the Jefferson salamander may be overwhelmed by the more common blue-spotted salamander. In addition, hybridization may substantially reduce the number of males in the population, resulting in some eggs not being viable, possibly increasing the likelihood of local extirpations (Jackson 1994, Bogart and Klemens 1997). However, there are no known local extirpations as a direct result of a reduction in males (Bogart and Klemens 1997).

Some local populations may be threatened by over-collection or pollution from pesticides (MNHP 1989). Artificial lighting can attract salamanders, leading them in the wrong direction during migration (USFS 2002k, SVE Herpetology Panel 2002). Increased predator populations such as turkeys, crows, and raccoons, due to human influence, can have a major effect on salamander populations as well (USFS 2002k, SVE Herpetology Panel 2002).

### **Information Gaps**

The SVE Herpetology Panel (2002) identified the following information gaps:

- The distribution of Jefferson salamanders is unknown for much of New England, due in large part to confounding by hybridization. Knowledge of the distribution of this species on the GMNF could be greatly improved with live-trapping and egg-mass searches in appropriate time periods and habitats.
- Habitat relationships, particularly for upland habitats, are poorly understood. Research has focused more on breeding pools.
- The roles of soil and water conditions need clarification, particularly with respect to acid rain and acidification of soils and water.

### **Management Direction Pertinent to the Jefferson Salamander**

There is no species-specific management direction in the revised Forest Plan for the Jefferson salamander. Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to this species. Forest-wide goals, objectives, standards, and guidelines address protection and enhancement of wetland habitat, including vernal or seasonal pools, and direct that management activity in upland habitats must not jeopardize or degrade these wetland habitats. This management direction provides benefits to the Jefferson salamander and its habitat.

The Forest Service works in close cooperation with the Vermont Fish and Wildlife Department, the Vermont Institute on Natural Science (VINS), and academic researchers to identify habitats or areas on the GMNF that are important to Jefferson salamanders, as well as other amphibian and reptiles.

### **Potential Management Effects**

#### **Direct and Indirect Effects**

As described above, Jefferson salamanders require both wetland and terrestrial habitats within dispersal distance of each other to complete their life cycle. Jefferson salamanders breed in vernal or semi-permanent pools, which are within or adjacent to their woodland habitat. Forest-wide management direction includes extensive guidance for the protection of wetlands, including vernal pools and other semi-permanent or seasonal pools that are important for Jefferson salamanders. This management direction does not vary by alternative.

Except when breeding, Jefferson salamanders prefer upland mature forest habitat that includes abundant leaf litter and woody debris. Jefferson salamanders are less tolerant of open habitats and habitat disturbance than are closely-related species. Accordingly, this species probably receives some benefit from alternatives that allocate greater acreage to management areas (MAs) that do not allow timber management and encourage development of continuous mature, late successional, or old growth forest

habitat and structure. Alternative A includes the greatest acreage of land on which timber management is prohibited (Table 4-4: 182,524 acres, 45%), due primarily to the newly acquired land (MA 9.2). Alternative D has the second greatest acreage of land without timber management (154,928 acres, 39%). The least acreage of land with no timber management is Alternative B (108,329 acres, 27%). Despite these differences, however, the overall effects on Jefferson salamanders may be equivocal because forest lands immediately adjacent to vernal pools and other wetlands are protected by Forest-wide direction. The Forest Service will limit activities within 100 feet of wetlands and seasonal pools to those that protect, manage, or improve the condition of those resources.

Allocation of land to MAs that employ longer rotations or otherwise restrict timber harvest could provide some benefit to this species' known or suspected habitat on the GMNF (J. Andrews, personal communication, July 2005). Alternative C allocates the greatest acreage to MAs that include longer rotations, whereas Alternative D allocates the greatest acreage of the escarpment area to special area designations. However, this species is most often found at low elevations (below 1,200 ft.) on the margins of the GMNF. Consequently, the GMNF is providing only a portion of the overall habitat requirements of local populations. Differences among alternatives are not likely to represent major differences in potential effects to Jefferson salamanders.

#### Cumulative Effects

The GMNF and Vermont are at the northeastern edge of the Jefferson salamander's range, and therefore at the periphery of its North American range. This species is most often found at low elevations (below 1,200 ft.) on the margins of the GMNF. Consequently, the GMNF is providing only a portion of the overall habitat requirements of local populations. The cumulative effects of implementing the revised Forest Plan under any of the five alternatives will be continued preservation, maintenance, and enhancement of suitable vernal pool and other wetland breeding habitat for the Jefferson salamander on the GMNF. The species may receive slightly greater long-term benefits from alternatives that allocate more land to Management areas that promote mature, late successional, and old forest habitats. These benefits may be overshadowed by population threats evident off the Forest or across the Northeast, such as habitat loss and hybridization with the blue-spotted salamander. The greatest long-term benefit to the species likely would be additional Forest Service land acquisition in low-elevation areas along the periphery of the Forest where the species occurs.

#### Determination and Rationale

Implementation of the revised Forest Plan and any of the proposed alternatives could affect individual Jefferson salamanders, but management actions prescribed by the Plan are ***Unlikely to Result in a Trend Toward Federal Listing or a Loss of Viability on the GMNF***. This determination is based largely on Forest-wide management direction that protects much of this species' habitat (vernal pools and other wetlands) on the Forest. Additionally, although adult salamanders may be affected by management actions in upland habitats adjacent to breeding pools, the likelihood of significant effect is small, considering the relatively small acreage of forestland near breeding pools that is likely to be affected.

### **Boulder Beach Tiger Beetle**

Information presented here on this species is derived from a review of the literature, which is documented in the Forest Plan revision project file referenced in the Bibliography (USFS 2002I).

The boulder beach tiger beetle is listed among the Regional Forester sensitive species (RFSS). Vermont does not list the boulder beach tiger beetle (VNNHP 2000).

#### Distribution, Status, and Trend

In Vermont, the boulder beach tiger beetle is known from the West River in the town of Jamaica (Windham County), and from the town of Bethel (Windsor County). The Jamaica site is located within the Proclamation Boundary of the GMNF, but not on or near the Forest (USFS 2002I).

The boulder beach tiger beetle occurs from Maine and southeastern Quebec, west to Indiana, and south to Georgia (Bousquet and Larochelle 1993, NatureServe 2004c). This beetle is thought to be relatively uncommon in New Hampshire, but locally common along the Saco River near Conway, which is where all extant documented occurrences have been (Dunn 1981, Wilson and Brower 1983). These occurrences are near the White Mountain National Forest (WMNF). Distributional data probably are a function more of surveys effort than the range of the species. Two historic occurrences are documented on the WMNF, in Martins Location on the Peabody River and in Pinkham's Grant on the Glen Ellis River. In Maine, it is documented only from Franklin County, far away to the east of the WMNF. The White Mountains appear to be at the northeastern range limit of the species (Dunn 1979, Wilson and Larochelle 1979, Nelson and LaBonte 1989, USFS 2002I).

This species may be declining over much of its range; however, available data are not sufficient to demonstrate trends (Acciavatti *et al.* 1992, *cited in* NatureServe 2004c; USFS 2002I).

The Natural Heritage ranks for the boulder beach tiger beetle are G3 globally, N3 in the United States and Canada, and S1 in Vermont (VNNHP 2000, NatureServe 2004c).

#### **Life History and Habitat Relationships**

The boulder beach tiger beetle is believed to have a two to three year life cycle (Leonard and Bell 1999). Adults appear in late summer, over-winter, and then become active in the late spring and early summer (Wilson and Larochelle 1979; Leonard and Bell 1999). Breeding presumably takes place during the summer.

Adults and larvae are found along the margins of clear, clean, permanent streams of mid-sized rivers with some degree of shading (Leonard and Bell, 1999). Adults prefer sandy areas near the water, sometimes intermixed with cobbles, but always lacking vegetation. It is likely that flooding and ice scouring helps keep this habitat free from vegetation. Larvae occur mostly in sandy-loam soil that is often some distance from the water's edge (Wilson and Larochelle 1979).

#### **Limiting Factors and Threats**

Threats facing this species are unknown. The boulder beach tiger beetle is known from very few locations, despite additional surveys in appropriate habitat. It is not known why more have not been located, so there are likely unknown factors limiting the species (USFS 2002I).

#### **Information Gaps**

Most information gaps for the boulder beach tiger beetle relate to a poor understanding of the species' abundance and distribution on or near the GMNF, and lack of basic natural history information (USFS 2002I). The species is known from within the Proclamation Boundary, but its presence on the Forest is unknown. The sizes and distributions of habitat patches required for this species are not well understood.

#### **Management Direction Pertinent to the Boulder Beach Tiger Beetle**

There is no species-specific management direction in the revised Forest Plan for the boulder beach tiger beetle. The Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to this species. Forest-wide goals, objectives, standards, and guidelines address protection and enhancement of riparian habitat, and direct that management activity in upland habitats must not jeopardize or degrade riparian habitat. This management direction provides benefits to the boulder beach tiger beetle and its habitat.

#### **Potential Management Effects**

##### **Direct and Indirect Effects**

Exactly what types of management activities might affect this species are unknown. It is likely that any activity that could change the disturbance regime or increase sedimentation in suitable habitat could reduce habitat suitability and impact individual beetles that were present. Dam construction downstream of a population could flood their habitat. Dam construction upstream could modify water flow and the

disturbance regime, resulting in additional vegetation or changes in water level affecting habitat suitability. Removal of an existing beaver dam upstream could flood and scour habitat. Road and trail construction, logging, and recreational use can all increase sediment levels if the activity is adjacent to or in direct line with the stream. It is unknown whether this would be detrimental to the boulder beach tiger beetle, but since this species prefers clear clean water, sedimentation could impact individuals and habitat suitability. Mitigation measures to reduce sediment reaching the stream near suitable habitat would reduce or prevent any potential impacts. Such effects are unlikely, however, because Forest-wide management direction includes extensive guidance for the protection of riparian habitats. This management direction does not vary by alternative.

#### Cumulative Effects

The GMNF is central to the boulder beach tiger beetles' range in the Northeast and in Vermont. This species is not known to occur on the GMNF, although it does occur within the Proclamation Boundary. The cumulative effects of implementing the revised Forest Plan under any of the five alternatives will be continued preservation, maintenance, and enhancement of suitable riparian habitat for the boulder beach tiger beetle on the GMNF. Long-term, sustainable management and protection of riparian habitat would contribute to the species' long-term viability in the region.

#### Determination and Rationale

Implementation of the revised Forest Plan and any of the proposed alternatives will have **No Impact** on the boulder beach tiger beetle. This determination is based on the fact that the riparian habitat for this species is protected under all five alternatives and the species is not known to occur on the Forest.

### **Odonates**

The insect order Odonata includes dragonflies and damselflies. This analysis is combined for four species of dragonfly that are RFSS on the GMNF: southern pygmy clubtail, forcipate emerald, harpoon clubtail, and gray petaltail. Information presented here on these species is derived from literature reviews, which are documented in the Forest Plan revision project file referenced in the Bibliography (USFS 2002m, 2002n, 2002o, 2002p; SVE Insect Panel 2002).

The *southern pygmy clubtail*, *forcipate emerald*, *harpoon clubtail*, and *gray petaltail* are listed among the Regional Forester sensitive species (RFSS). Vermont does not list any odonates as endangered, threatened, or species of special concern (VNNHP 2000).

#### Distribution, Status, and Trend

Distribution data for odonates in New England is limited, although lack of occurrence records may be a function of survey effort more than lack of presence. Information for Vermont frequently is limited to a few known sightings. Current status and trends also are poorly understood for most species.

The *southern pygmy clubtail* is known from one site on the southern half of the GMNF, and four sites in northern Vermont (P. Brunelle, personal communication, May 2005); it probably occurs throughout Vermont, with the exception of the Champlain lowlands (Carle 1994). The species occurs primarily in the eastern United States, from New England to Georgia and west to Ohio, Kentucky, and Tennessee (USFS 2002m, NatureServe 2004c). The southern pygmy clubtail is listed as a species of special concern in Maine; one odonate expert recommended that the southern pygmy clubtail warrants special concern by the GMNF because it may be at greater risk because it is at the edge of its range (USFS 2002m). The Natural Heritage ranks for the southern pygmy clubtail are G4 globally, N4 in the United States, and S2 in Vermont (VNNHP 2000, NatureServe 2004c).

The *forcipate emerald* is known from two sites on the southern half of the GMNF, one site near the north half of the GMNF, and one other occurrence in northeastern Vermont (Carle 1994, Brunelle 2004). Although status and trend are not known for Vermont, the species may be stable or increasing in Maine and generally range-wide. Local odonate experts recommended that the forcipate emerald warrants

special concern by the GMNF (USFS 2002n). The GMNF is central to the Vermont distribution of the forcipate emerald, but at the periphery of the North American distribution. This is a more western and northern species, occurring in northern North America, including most of Canada and the northern tier of states, from Minnesota to New England and south to Pennsylvania and West Virginia (USFS 2002n, NatureServe 2004c). The Natural Heritage ranks for the forcipate emerald are G5 globally, N4 in the United States, N5 in Canada, and S2 in Vermont (VNNHP 2000, NatureServe 2004c).

Local odonate experts were not in agreement about the status of the *harpoon clubtail* in northern New England; two experts indicated that this species warrants concern because of limited habitat on the GMNF, whereas another expert thinks it is fairly widespread and common (USFS 2002o). The *harpoon clubtail* occurs in northeastern North America, with a spotty distribution from Nova Scotia, New Brunswick, and Ontario south to North Carolina, Virginia, and Kentucky (USFS 2002o, NatureServe 2004c). The GMNF is central to the Vermont and North American distribution of the harpoon clubtail. The Vermont Natural Heritage Inventory does not keep records of its Odonate species. The harpoon clubtail is known from four records in northern Vermont, and may occur in the Deerfield River in the Manchester District of the GMNF (SVE Insect Panel 2002). Status and trends for the harpoon clubtail are unknown. The harpoon clubtail is not rare in northern New Hampshire, but it is a species of special concern in Maine (USFS 2002o). The Natural Heritage ranks for the harpoon clubtail are G4 globally, N4 in the United States, N3 in Canada, SNR (not ranked) in Vermont (VNNHP 2000, NatureServe 2004c).

The *gray petaltail* is a known from a single, report in Vermont; this would be the only recent (since June 1900) record for New England if it is confirmed (USFS 2002p; P. Brunelle, personal communication, May 2005). This is primarily a southern species. It occurs across eastern North America, from Florida and Georgia north to New York, and west to Michigan, Illinois, Tennessee, Kentucky, Kansas, Oklahoma, and Texas. It does not occur in Canada (USFS 2002p, NatureServe 2004c). Status and trend are unknown. The Natural Heritage ranks for the gray petaltail are G4 globally, N4 in the United States, and SNR (not ranked) in Vermont (VNNHP 2000, NatureServe 2004c). The species was identified in Vermont for the first time in 1995 (F.L. Carle and GMNF, unpublished data).

### **Life History and Habitat Relationships**

The adult stage for odonates typically lasts only one or two months, therefore odonates have a single reproductive season. Immediately after emerging, young adults disperse from the water into the surrounding lands. For dragonflies, the dispersal period lasts from a few days to two or three weeks. Females lay eggs in water immediately after mating. Most dragonflies deposit their eggs directly onto the surface of the water or into mud at the water's edge. Petaltails insert their eggs into plant tissue, either above or below to the water's surface. The eggs of most dragonfly species hatch one to three weeks later (WDA 2004).

Dragonfly larvae are completely aquatic, breathing through gills. Like all arthropods, they have a hard exoskeleton that must be repeatedly molted as the larvae grow through developmental stages, or instars. All growth takes place in larval forms. Larval development can take as long as four years. Fully-developed larvae typically emerge onto a vertical surface, such as the stem of a reed or other aquatic vegetation. The larval exoskeleton breaks open and the adult dragonfly emerges. The newly-emerged adult pumps blood throughout its body, which expands the body and wings. Shortly thereafter the adult is capable of flight (WDA 2004).

Dragonflies are voracious predators. Larvae prey on roe and larvae of fish and amphibians and on insects. They in turn are preyed on by fish and frogs. Adult odonates feed on blackflies, gnats, mosquitoes, and other flying insects (Hilton 1987, Brunelle 1999, WDA 2004). Odonates are usually the top predators in fishless freshwater systems (Dunkle 2000).

Two of these odonate species, the southern pygmy clubtail and harpoon clubtail, are closely tied to riparian habitats:

The *southern pygmy clubtail* prefers the headwaters of small, shady, spring-fed creeks, preferring those with clean sand or mud substrate and shallow water (SaintOurs 2002, USFS 2002m). It frequently is found in association with native brook trout (*Salvelinus fontinalis*) (Carle 1994). Larvae may burrow in the bottom of pools or hide around pancake-sized rocks (Carle 1994, USFS 2002m).

The *harpoon clubtail* typically occurs in large streams and small rivers that include pools, or deep portions of the stream where there is some eddy current (Sankey 1999, USFS 2002o). Larvae prefer substrates composed of silt-sized sediment. Habitat requirements apparently are not as specialized as for many other clubtails, but suitable habitat probably is not widespread on the GMNF (USFS 2002o).

The forcipate emerald and gray petaltail occur in *wooded wetlands*:

The *forcipate emerald* inhabits small spring-fed streams and shallow puddles that occur in wooded bogs or fens, or fen-like habitats that can form upstream of beaver dams and similar impoundments. They may occur in wet areas that are no more than small pools associated with flowing groundwater. Soft benthos and slow current apparently are key habitat features (Carle 1994, Sankey 1999, USFS 2002n, Brunelle 2004).

The *gray petaltail* occurs in small forested wetlands, including permanent, spring-fed, sunny hillside seeps, bogs, fens, and swamps in deciduous forest. Larvae may occur near the uphill edges of permanent seeps in deciduous forests, hiding between or under leaves in thin sheets of flowing water (Dunkle 1981, Waltz 1998, USFS 2002p). Unlike other dragonflies, adult gray petaltails usually perch on tree trunks or occasionally on horizontal logs, and rarely weed stems or the ground (Dunkle 1981). Preferred habitat includes intermediate successional forests where abundant openings in the canopy create abundant sunny spots, but undergrowth is dense with abundant saplings for perching.

### **Limiting Factors and Threats**

Numerous threats apply to all species of odonates. In general, habitat vulnerability for odonates is largely with respect to aquatic larvae than to the free-flying adults. Factors affecting water quality and structure can have an impact on all larvae in a system, whereas altering forest canopy and vegetation adjacent to a wetland (assuming no impact on water quality, temperature, wetland structure, etc.) may have a lesser impact on predation of adult odonates by birds (P. Brunelle, personal communication, May 2005). Dragonflies and damselflies respond more to habitat structure than to water chemistry. Therefore, loss of habitat structure represents a threat to these species. Habitat can be lost or degraded through impoundment, channelization, dredging, beaver activity, siltation, and pollution (USFS 2002 m, 2002n, 2002o, 2002p; Brunelle 2004).

The riparian species, southern pygmy clubtail and harpoon clubtail, prefers shaded stream habitats. The significant habitat risk for these species is the waterway, itself (P. Brunelle, personal communication, May 2005). Removal of canopy can make stream habitat unsuitable for these species (SaintOurs 2002; USFS 2002m, 2002o).

Siltation of wetlands can reduce the suitability of habitat. Erosion or increased sedimentation in streams can result from many activities, including construction or timber harvests, maintenance of roads or trails, or heavy foot traffic on trails. The southern pygmy clubtail seems particularly intolerant of excessive sedimentation, preferring clean sandy substrates (SaintOurs 2002).

Introduction of fish or other predators can degrade the quality of habitat used by larvae (Morin 1984). Changes in forest canopy and vegetation may alter the vulnerability of adult odonates to predation from birds, although predation rates and increases or decreases in predation as a consequence of changes in vegetation are difficult to assess (P. Brunelle, personal communication, May 2005).

Forcipate emeralds and gray petaltails occur in small wooded wetlands, occasionally little more than seeps or flowing groundwater. Such sites may be less obvious than riparian habitat and there is a danger that they may be overlooked during project analyses.

### **Information Gaps**

For the four species of odonates in general, we have little information about the species abundance and distribution on the Forest and in the surrounding region (USFS 2002 m, 2002n, 2002o, 2002p). The gray petaltail, in particular, is a southern species known in recent times in New England from a single sighting on the GMNF (earlier records are from near Manchester, NH, in June 1900: P. Brunelle, personal communication, May 2005). It is unknown if the GMNF observation was a single, extralimital occurrence or if the species is regular resident of the area (USFS 2002p).

Landscape-level habitat preferences and needs are poorly understood for odonates. This includes questions about the sizes, distribution, and connectivity of habitat patches necessary to promote viable populations of these species (USFS 2002 m,n,o,p).

### **Management Direction Pertinent to Odonates**

There is no species-specific management direction in the revised Forest Plan for dragonflies. Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to these species. Forest-wide goals, objectives, standards, and guidelines address protection and enhancement of riparian and wetland habitats, and direct that management activity in upland habitats must not jeopardize or degrade riparian and wetland habitats. This management direction provides benefits to these dragonfly species and their habitat.

### **Potential Management Effects**

#### **Direct and Indirect Effects**

As described above, these four odonate species are closely linked to wetland and aquatic habitats. The southern pygmy clubtail and the harpoon clubtail, are closely tied to riparian habitats, whereas the forcipate emerald and gray petaltail are more typical of wooded wetlands. Forest-wide management direction, particularly in standards and guidelines, provides extensive protection of riparian and wetland habitats. This management direction does not vary by alternative.

Forcipate emeralds and gray petaltails may occur in small wooded wetlands, occasionally little more than seeps or flowing groundwater. Such sites may be less obvious than riparian habitat and there is a danger that they may be overlooked during project analyses. If these sites are overlooked during project-level analysis, they could be degraded by a timber management activity. Conversely, timber management adjacent to these wooded wetland sites could enhance their suitability for odonates by creating sunny openings near the forest floor. With appropriate application of standards and guidelines, these wooded wetland sites should be protected equally under each of the five alternatives.

#### **Cumulative Effects**

The cumulative effects of implementing the revised Forest Plan under any of the five alternatives will be continued preservation, maintenance, and enhancement of suitable riparian and wetland habitat for odonates on the GMNF. Long-term, sustainable management and protection of these habitats would contribute to the species' long-term viability in the region.

### **Determination and Rationale**

Implementation of the revised Forest Plan and any of the proposed alternatives will have **No Impact** on the southern pygmy clubtail or the harpoon clubtail. This determination is based on the fact that wetland habitats occupied by these species, particularly riparian areas, are protected under all five alternatives, and management direction in the revised Plan includes goals, objectives, standards, and guidelines to protect important habitat for RFSS.

Implementation of the revised Forest Plan and any of the proposed alternatives may impact the forcipate emerald or the gray petaltail, but management actions prescribed by the Plan are **Unlikely to Result in a Trend Toward Federal Listing or a Loss of Viability on the GMNF** for either species. This determination is based on the fact that wooded wetlands and other wetland habitats occupied by these



species are protected under all five alternatives, and management direction in the revised Plan includes goals, objectives, standards, and guidelines to protect important habitat for RFSS.

## Brook Floater

Information presented here on this species is derived from a review of the literature, which is documented in the Forest Plan revision project file referenced in the Bibliography (USFS 2002q, SVE Invertebrate Panel 2002).

The brook floater, a freshwater mussel, is a Regional Forester sensitive species (RFSS); it is listed as threatened by Vermont and by the American Fisheries Society (VNNHP 2000, NatureServe 2004c).

### **Distribution, Status, and Trend**

The brook floater currently is found only in southern Vermont and in the southern counties of New Hampshire (Fichtel and Smith 1995). It is not known to occur on the GMNF, although it is found within the proclamation boundary on the West River in Jamaica, Vermont. The GMNF is peripheral to the species range in North America and in Vermont (Fichtel and Smith 1995, USFS 2002q).

The brook floater is found in streams and rivers of the Atlantic coastal region, from South Carolina to Nova Scotia and New Brunswick. It has also been reported in West Virginia in part of the Ohio-Mississippi River drainage. The distribution has become spotty within this range, notably with numerous large populations in Maine. More extant populations occur in Maine than in the rest of the Northeast combined (Clark 1985 *cited in* NatureServe 2004c, NatureServe 2004c). Atlantic slope distribution implies that northern New England is at the edge of the species range since it does not extend into Quebec and Ontario; the species is known in Canada only from historical records (USFS 2002q, NatureServe 2004c).

The brook floater is a freshwater mussel that has experienced significant declines throughout its range; the species has been lost from 60 to 80 sites range-wide. In addition, numbers within existing populations have sharply declined. It is possible that more populations have been lost than will be discovered. Some known populations consist primarily of older individuals with little sign of recruitment. The species has also declined in Massachusetts in recent decades (USFS 2002q, NatureServe 2004c). In Vermont, the species is assumed to be declining (VNNHP 2003).

The Natural Heritage ranks for the brook floater are G3 globally, N3 in the United States, NH (known only from historical records) in Canada, and S1 in Vermont (VNNHP 2000, NatureServe 2004c).

### **Life History and Habitat Relationships**

Brook floaters breed during summer. Males release sperm into the water column, which is then picked up by the female while filtering. Egg and partial larval development occur within the female. Females hold glochidia (larvae) in their gills until the following spring. Once larvae are released into the water, they attach themselves to the gills or fins of a host fish, where they feed for several weeks before dropping to the stream bottom. It is here that the glochidia develop into adult bivalves (Fichtel and Smith 1995). Larvae of freshwater mussels can travel considerable distances while attached to host fish (Martin 1997).

The lifespan of the brook floater is unknown, but the lifespan of other freshwater mussels in Vermont ranges from 15 years for the dwarf wedgemussel (*Alasmidonta heterodon*) to over 100 years for the eastern pearlshell (*Margaritifera margaritifera*) (Fichtel and Smith 1995).

Adult brook floaters are filter feeders, consuming plankton and detritus (Fichtel and Smith 1995).

Glochidial hosts for the brook floater include blacknose dace (*Rhinichthys atratulus*), pumpkinseeds (*Lepomis gibbosus*), and slimy sculpins (*Cottus cognatus*) (Wicklowsky 1995 *cited in* Fichtel and Smith 1995).

Freshwater mussels are important elements of the freshwater food chain. Glochidia and juveniles are prey for fish and birds; adults are eaten by several mammal species (Martin 1997).

The brook floater spends its whole life in riverine habitat. It generally occurs in shallow water of streams and small rivers, particularly in rapids and riffles among a matrix of firmly packed sand, gravel, cobble, or among large rocks. It is generally found in a range of medium water flow conditions, but not in high-gradient streams with very fast water flow or in slow water. In Maine, however, it has been found in small sandy-bottomed ponds and streams with moderate to slow flow. It is often found associated with rooted vegetation (Fichtel and Smith 1995, NatureServe 2004c). This preferred habitat is abundant, although it may be negatively altered by siltation and pollution.

#### **Limiting Factors and Threats**

Habitat loss is the most significant threat to all freshwater mussels in northern New England. Suitable habitat can be degraded by alteration from construction of dams, siltation, dredging, channeling or diversion, gravel mining, and other activities that affect water flow (Fichtel and Smith 1995, USFS 2002q).

Water pollution is also believed to strongly affect populations (waste water plant releases, releases from poultry processing plants, and point source pollution have been specified), though there is little data available regarding levels of contaminants resulting in mortality of freshwater mussels (Fichtel and Smith 1995, USFS 2002q).

The zebra mussel (*Dreissena polymorpha*), found in Lake Champlain in the last decade, has not yet invaded Brook floater habitat, but research shows that suitable habitat overlaps for the two species. This could pose a serious threat to the Brook floater and other freshwater mussels (Fichtel and Smith 1995, USFS 2002q).

The brook floater requires a fish host to reproduce; therefore, any limiting factors present for the host fish would also affect the brook floater (USFS 2002q).

#### **Information Gaps**

Information gaps relative to the brook floater relate to its abundance and distribution in the GMNF region and whether or not this species occurs on the Forest.

#### **Management Direction Pertinent to the Brook Floater**

There is no species-specific management direction in the revised Forest Plan for the brook floater. The Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to this species. Forest-wide goals, objectives, standards, and guidelines specifically address protection and enhancement of riparian habitat, and direct that management activity in upland habitats must not jeopardize or degrade riparian habitat. This management direction provides benefits to the brook floater and its habitat.

#### **Potential Management Effects**

##### **Direct and Indirect Effects**

Brook floaters occur in riverine habitat characterized by a medium rate of water flow. Forest-wide management direction includes extensive and specific protection to riparian and riverine habitat. This management direction does not vary by alternative. Therefore, the revised Forest Plan should have no direct or indirect effects on the brook floater.

##### **Cumulative Effects**

The GMNF is peripheral to the brook floater's range in North America and in Vermont. This species is not known to occur on the GMNF, although it is known to occur within the Proclamation Boundary. The cumulative effects of implementing the revised Forest Plan under any of the five alternatives will be continued preservation, maintenance, and enhancement of suitable riparian and riverine habitat for the

brook floater on the GMNF. Long-term, sustainable management and protection of this habitat would contribute to the species' long-term viability in the region.

#### **Determination and Rationale**

Implementation of the revised Forest Plan and any of the proposed alternatives will have **No Impact** on the brook floater. This determination is based on the fact that riparian and riverine habitat occupied by this species is protected under all five alternatives, and management direction in the revised Plan includes goals, objectives, standards, and guidelines to protect important habitat for RFSS.

### **Creek Heelsplitter**

Information presented here on this species is derived from a review of the literature, which is documented in the Forest Plan revision project file referenced in the Bibliography (USFS 2002r, SVE Invertebrate Panel 2002).

The creek heelsplitter, a freshwater mussel, is listed among the Regional Forester sensitive species (RFSS). Vermont does not list the creek heelsplitter (VNNHP 2000).

#### **Distribution, Status, and Trend**

The creek heelsplitter is found within the GMNF proclamation boundary in the headwaters of Otter Creek, and it is known to occur in only a few other locations in Rutland, Lamoille, Addison, and Essex counties in Vermont (Fichtel and Smith 1995). It is not known to occur on GMNF land (USFS 2002r).

The creek heelsplitter is a primarily Midwestern species. Its distribution radiates in all directions from the Great Lakes area: south to Kentucky, east to Vermont, north to northern Quebec, and west to Alberta, North Dakota, and South Dakota (NatureServe 2004c). Vermont and the GMNF are at the periphery of the species' range.

Status and trend for this species are not well documented. The Natural Heritage ranks for the creek heelsplitter are G5 globally, N5 in the United States and Canada, and S2 in Vermont (VNNHP 2000, NatureServe 2004c).

#### **Life History and Habitat Relationships**

The creek heelsplitter is believed to be hermaphroditic (having both male and female reproductive organs in the same animal). Fertilization takes place in late summer. Eggs develop within the adults, as do the glochidia (larvae), which attach to the adults' gills until late spring or early summer of the following year. Once larvae are released into the water, they attach themselves to the gills or fins of a host fish, where they feed for several weeks before dropping to the stream bottom. It is here that the glochidia develop into adult bivalves (Fichtel and Smith 1995). Larvae of freshwater mussels can travel considerable distances while attached to host fish (Martin 1997).

The lifespan of the creek heelsplitter is unknown, but the lifespan of other freshwater mussels in Vermont ranges from 15 years for the dwarf wedgemussel (*Alasmodonta heterodon*) to over 100 years for the eastern pearlshell (*Margaritifera margaritifera*) (Fichtel and Smith 1995).

Adult creek heelsplitters are filter feeders, consuming plankton and detritus (Fichtel and Smith 1995).

Hosts species for the glochidia of creek heelsplitter are not known (Fichtel and Smith 1995).

Freshwater mussels are important elements of the freshwater food chain. Glochidia and juveniles are prey for fish and birds; adults are eaten by several mammal species (Martin 1997).

The Creek heelsplitter often occurs in areas that mark the beginning of a small or medium river where there is fine gravel or sand; it is rarely found in larger rivers. In Vermont, it is often found in headwater of

small to medium rivers, particularly those in the St. Lawrence River drainage. They do not occur in lakes (Fichtel and Smith 1995). Habitat appears to be abundant across its range (USFS 2002r).

#### **Limiting Factors and Threats**

Habitat loss is the most significant threat to all freshwater mussels in northern New England. Suitable habitat can be degraded by alteration from construction of dams, siltation, dredging, channeling or diversion, gravel mining, and other activities that affect water flow (Fichtel and Smith 1995, USFS 2002r).

Water pollution is also believed to strongly affect populations (waste water plant releases, releases from poultry processing plants, and point source pollution have been specified), though there is little data available regarding levels of contaminants resulting in mortality of freshwater mussels (Fichtel and Smith 1995, USFS 2002r).

The zebra mussel (*Dreissena polymorpha*), found in Lake Champlain in the last decade, has not yet invaded creek heelsplitter habitat, but research shows that suitable habitat overlaps for the two species. This could pose a serious threat to the creek heelsplitter and other freshwater mussels (Fichtel and Smith 1995, USFS 2002r).

The creek heelsplitter requires a fish host to reproduce; therefore, any limiting factors present for the host fish would also affect the creek heelsplitter (USFS 2002r).

#### **Information Gaps**

Information gaps relative to the creek heelsplitter relate to its abundance and distribution in the GMNF region and whether or not this species occurs on the Forest.

#### **Management Direction Pertinent to the Creek Heelsplitter**

There is no species-specific management direction in the revised Forest Plan for the creek heelsplitter. Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to this species. Forest-wide goals, objectives, standards, and guidelines specifically address protection and enhancement of riparian habitat, and direct that management activity in upland habitats must not jeopardize or degrade riparian habitat. This management direction provides benefits to the creek heelsplitter and its habitat.

#### **Potential Management Effects**

##### **Direct and Indirect Effects**

Creek heelsplitters occur in riparian or riverine habitat, typically in the headwaters of small- or medium-sized rivers. Forest-wide management direction includes extensive and specific protection to riparian and riverine habitat. This management direction does not vary by alternative. Therefore, the revised Forest Plan should have no direct or indirect effects on the creek heelsplitter.

##### **Cumulative Effects**

The creek heelsplitter is a primarily Midwestern species. Vermont and the GMNF are peripheral to its range. This species is not known to occur on the GMNF, although it is known to occur within the Proclamation Boundary. The cumulative effects of implementing the revised Forest Plan under any of the five alternatives will be continued preservation, maintenance, and enhancement of suitable riparian and riverine habitat for the creek heelsplitter on the GMNF. Long-term, sustainable management and protection of this habitat would contribute to the species' long-term viability in the region.

#### **Determination and Rationale**

Implementation of the revised Forest Plan and any of the proposed alternatives will have **No Impact** on the creek heelsplitter. This determination is based on the fact that riparian and riverine habitat occupied by this species is protected under all five alternatives, and management direction in the revised Plan includes goals, objectives, standards, and guidelines to protect important habitat for RFSS.

## Chapter 5 – Analysis of Effects, Regional Forester Sensitive Plants

### Introduction

In this chapter, the effects of plan revision alternatives are discussed in terms of the habitat groups to which plant RFSS (sensitive plants) belong. Each grouping discusses habitats, limiting factors, threats, relevant management direction, and effects to populations and habitat. Due to the programmatic nature of the revised Forest Plan, we determined this grouping approach to be the most efficient method of communicating differences in effects of Forest Plan alternatives on sensitive plants. More specific effects on certain sensitive plant sites are determined at the project level and are therefore beyond the scope of this document. The analysis area for direct and indirect effects is all lands administered by the GMNF, including the Appalachian Trail corridor in Vermont. For cumulative effects, unless otherwise specified the analysis area is defined as all lands administered on other ownerships, both public and private, within the biophysical regions that encompass all or parts of the GMNF, including the Northern and Southern Green Mountains, the Southern Vermont Piedmont, the Vermont and Champlain Valleys, and the Taconic Mountains. These biophysical regions are presumed to include the bulk of suitable habitats for species of viability concern found on the Forest, and are most likely to provide sources for populations of these species on the GMNF. Species ranges were considered and some cumulative effects areas were enlarged or narrowed to most appropriately address effects. Table 5-1 provides a listing of the sensitive plants to be discussed here, along with the habitat groups with which they are associated in the analysis below. For each habitat group there is a table with further details on habitat and occurrences for each sensitive species on the GMNF.

**Table 5-1: Regional Forester sensitive plants and their habitat group affinities.**

Species	Alpine and subalpine habitat	Rock and cliff habitat	Barrens or open upland	Aquatic habitat	Shore habitat	Open wetland	Forested wetland	Rich woods	Dry and warm forest	Conifer forest
<i>Agrostis mertensii</i>	X	X								
<i>Aureolaria pedicularia</i> var. <i>pedicularia</i>									X	
<i>Blephilia hirsuta</i>						X	X	X		
<i>Calamagrostis stricta</i> ssp. <i>inexpansa</i>		X								
<i>Cardamine parviflora</i> var. <i>arenicola</i>		X							X	
<i>Carex aestivalis</i>								X	X	
<i>Carex aquatilis</i> var. <i>substricta</i>					X	X				
<i>Carex argyrantha</i>		X								
<i>Carex atlantica</i>						X				
<i>Carex bigelowii</i> ssp. <i>bigelowii</i>	X									
<i>Carex foenea</i>		X	X							
<i>Carex lenticularis</i> var. <i>lenticularis</i>					X					
<i>Carex michauxiana</i>					X	X				
<i>Carex schweinitzii</i>						X	X			
<i>Carex scirpoidea</i>		X								
<i>Clematis occidentalis</i> var. <i>occidentalis</i>		X							X	
<i>Collinsonia canadensis</i>								X		
<i>Conopholis americana</i>									X	
<i>Cryptogramma stelleri</i>		X								
<i>Cypripedium parviflorum</i> var. <i>pubescens</i>							X	X		

**Table 5-1: Regional Forester sensitive plants and their habitat group affinities.**

Species	Alpine and subalpine habitat	Rock and cliff habitat	Barrens or open upland	Aquatic habitat	Shore habitat	Open wetland	Forested wetland	Rich woods	Dry and warm forest	Conifer forest
<i>Cypripedium reginae</i>						X	X			
<i>Desmodium paniculatum</i>									X	
<i>Draba arabisans</i>		X							X	
<i>Dryopteris filix-mas</i>								X		
<i>Eleocharis intermedia</i>					X	X				
<i>Eupatorium purpureum</i>								X	X	
<i>Galium kamtschaticum</i>							X			
<i>Geum laciniatum</i>					X	X				
<i>Huperzia appalachiana</i>	X	X								
<i>Isoetes tuckermanii</i>				X						
<i>Isotria verticillata</i>									X	
<i>Juglans cinerea</i>							X	X		
<i>Juncus trifidus</i>	X	X								
<i>Lespedeza hirta</i>			X						X	
<i>Muhlenbergia uniflora</i>					X	X				
<i>Myriophyllum farwellii</i>				X						
<i>Myriophyllum humile</i>				X	X					
<i>Nabalus trifoliolatus (=Prenanthes trifoliolata)</i>									X	
<i>Panax quinquefolius</i>								X		
<i>Peltandra virginica</i>					X					
<i>Phegopteris hexagonoptera</i>								X	X	
<i>Pinus rigida</i>		X	X						X	
<i>Plantago (=Littorella) americana</i>				X	X					
<i>Platanthera orbiculata</i>							X	X	X	X
<i>Polemonium vanbruntiae</i>					X	X	X			
<i>Potamogeton bicupulatus</i>				X	X					
<i>Potamogeton confervoides</i>				X						
<i>Potamogeton hillii</i>				X						
<i>Pyrola chlorantha</i>							X		X	X
<i>Rhodiola (=Sedum) rosea</i>		X								
<i>Ribes triste</i>							X	X		X
<i>Saxifraga paniculata</i> ssp. <i>neogaea</i>		X								
<i>Scheuchzeria palustris (=ssp. americana)</i>					X	X				
<i>Selaginella rupestris</i>		X								
<i>Sisyrinchium angustifolium</i>			X			X				
<i>Sisyrinchium atlanticum</i>			X			X				
<i>Solidago squarrosa</i>		X	X						X	
<i>Sorbus decora</i>										X
<i>Sparganium fluctuans</i>				X						
<i>Torreyochloa pallida</i> var. <i>fernaldii</i>					X	X				
<i>Utricularia geminiscapa</i>				X						
<i>Utricularia resupinata</i>				X	X					
<i>Uvularia perfoliata</i>								X	X	
<i>Vaccinium uliginosum</i>	X									
<i>Woodsia glabella</i>		X								

## Summary of Species Determinations

After reviewing the proposed action and alternatives, the literature and records, and consulting individuals, the Biological Evaluation has determined that the revised Forest Plan and its alternatives ***May Impact Individuals but is Not Likely to Result in a Trend to Federal Listing or Loss of Viability*** for all sensitive plants evaluated. There are minor differences in relative benefit and impact among the alternatives, which are discussed in the effects analysis for all sensitive species.

### Rationale:

Based on the analysis of effects contained in this BE, implementation of any alternative has some potential, however minor, to impact individuals of any given RFSS, although not causing a loss of viability or trend towards federal listing. It is the nature of the Forest Plan, and the agency's multiple use mission, to balance the benefits derived from the Forest. However, the agency is also legally required to maintain viable populations of plants on the Forest, and it is agency policy to protect species of viability concern through designation as RFSS, and avoid or minimize impacts to RFSS so that such impacts do not contribute to a loss of viability or result in the need for federal listing of species (FSM 2670.32). This legal, regulatory, and policy direction is captured in Goal 2 of the revised Plan, which seeks to maintain and restore habitats to produce viable and sustainable populations of species, as well as in standards and guidelines. This direction is constant across all alternatives.

The BE has also determined that one sensitive plant species, *Juglans cinerea*, is at high risk of loss of viability. All alternatives may impact *Juglans cinerea* but are not likely to cause a trend to federal listing. The primary risk factor judged to cause a high risk of loss of viability under all alternatives is its susceptibility to butternut canker, a disease that is killing butternut trees across its range. Six populations of butternut have been assessed for the canker on the GMNF, and all had signs of infection, although some were still healthy, and one appeared to be walling off the infection (Torsello and Allen 1994). Activities the Forest can undertake to contribute to viability of this species include protection of butternut trees that are healthy or showing signs of disease resistance, providing opportunities for reproduction of butternut, and cooperating with other agencies in testing disease-resistant genotypes. Regardless of these activities, however, the species is expected to decline and remain at high risk for loss of viability.

## Effects Common to All Alternatives across Habitats

All alternatives promote the protection, enhancement or maintenance of sensitive plants and the habitats on which these species depend. This level of attention is driven by laws, regulations, and agency policy, all of which require the agency to maintain viable populations. Although the role that the GMNF plays in contributing to the conservation of these species varies by alternative (for example by providing differing amounts and quality of suitable habitat conditions), all alternatives were developed with the premise that risks to viability will be minimized. Where adverse impacts cannot be avoided, management must not result in a trend toward federal listing.

The goals, objectives, standards, guidelines, and management area direction noted in Chapter 2 will be applied when developing and implementing management activities on the GMNF. The direction for TES species contained within these elements of the revised Forest Plan does not vary by alternative, and so there are no differences in effects on sensitive plants due to this direction across alternatives.

Direction for protection of RFSS found in agency and departmental policies and regulations set a high standard for ensuring limited negative effects of management activities on these species. This direction, in combination with goals, objectives, standards, and guidelines, is designed to ensure that when management activities do occur, any effects on species are not likely to result in a trend toward federal listing or a loss of viability on the Forest. However, depending on the species of concern, management activities can still have positive or negative effects without resulting in these trends or losses. The effects

analyses below for sensitive plants and their habitats detail the impacts that can result from management activities. Because management activities can be allowed or prohibited depending upon direction associated with each management area, and because management areas are distributed differently across the Forest depending on the alternative, the general level or extent of the effects on sensitive plants and their habitats may also vary by alternative. When this is the case, those differences are also discussed below.

## **Species of Alpine and Subalpine Habitats**

### **Habitat Description and Distribution**

The GMNF manages the southernmost extent of alpine habitat in Vermont. Here, the predominant forms of alpine habitat are dry to mesic meadows, low shrubby heaths, and barren lichen-covered rock, all part of the alpine dry/mesic heath/meadow system. Subalpine krummholz habitat occurs in the more sheltered locations at the edge of the alpine zone, and consists of stunted black spruce and balsam fir. Alpine/subalpine habitats for purposes of this discussion are areas mapped as Ecological Landtype (ELT) 14, which is defined by soils that undergo cryoplanation, a soil process that involves repeated freezing and thawing of the soil. This habitat encompasses about 1,000 acres of the Forest in two patches in the northern district in the areas of Lincoln Ridge and the Presidential Range. Small patches of subalpine krummholz elsewhere on the GMNF that are not mapped as ELT 14 are considered part of the conifer or rock/cliff habitat groups, depending upon how much tree cover exists.

Exposure to the elements, especially in winter, is a defining aspect of these habitats. They contain a spectrum of species, ranging from those needing very exposed sites with intense wind disturbance to those that benefit from exposure and wind but need some sheltering. At the extreme end of the spectrum, cold, wind, and snow and ice blast result in harsh environmental conditions in which few species can survive, thus reducing competition. Habitats in this grouping typically have dry to mesic moisture conditions, well-drained, thin, acidic soils, desiccation, and low nutrient availability. They are usually associated with stony areas and convex landforms that are more exposed.

Table 5-3 shows the five RFSS plants that are sensitive on the GMNF with affinities for alpine and subalpine habitat, including their specific habitat requirements, biological factors that may be important to viability, and numbers on the GMNF. This information is based on literature reviews and discussions with botanists regarding these species, and is documented in species summaries (USDA 2004) and the project file.



<b>Table 5-3: RFSS Plants of Alpine and Subalpine Habitats and factors affecting their viability</b>			
<b>Species</b>	<b>Habitat Requirements</b>	<b>Biological Factors</b>	<b>Occurrences (extant or historical)</b>
<i>Agrostis mertensii</i>	Peaty or rocky soil of alpine meadows and rocky ledges in the drier, more exposed locations; will sometimes also occur on subalpine bare rock summits.	Effective seed disperser; clonal habit with plants sharing root system and resources	4 extant in VT; 1 extant in the cumulative effects analysis area; 1 extant on the GMNF.
<i>Carex bigelowii</i> ssp. <i>bigelowii</i>	Rocky ledges and meadows of the alpine dry/mesic heath/meadow system, on the flatter, wetter, less exposed sites with thicker soils; not with krummholz	Slow-growing clonal growth habit	4 extant in VT; 2 extant in the cumulative effects analysis area; 1 extant on the GMNF.
<i>Huperzia appalachiana</i>	Open habitats of massive or loose, acidic rocks of the alpine zone; exposed cliffs, talus, boulders, and ledges in the subalpine zone; strong affiliation with wet, seepy microsites; generally above 3000' in the Northeast	Inbreeding from vegetative reproduction; competition from hybrid fir-clubmosses; plant collecting	5 extant and 4 historical in VT; 1 extant and 3 historical in the cumulative effects analysis area; 2 historical from GMNF but considered still likely there
<i>Juncus trifidus</i>	Primarily rock crevices of moist to dry alpine meadows; also subalpine cliffs and krummholz; often in association with <i>Carex bigelowii</i> and <i>Vaccinium uliginosum</i> .	Establishes at a site by seed but expands vegetatively; heavy seeds distributed by birds	6 extant and 1 historical from VT; 2 extant in the cumulative effects analysis area; 1 extant from the GMNF.
<i>Vaccinium uliginosum</i>	Open, dry to mesic areas of alpine dry/mesic heath meadows, in less extreme wet or exposed areas, but not with krummholz	Clonal habitat; dense slow growth inhibits seedling survival; mycorrhizal relationship; highly competitive	8 extant and 1 historical from VT; 2 extant in the cumulative effects analysis area; 1 extant from the GMNF.

### **Limiting Factors and Threats**

The primary limiting factor to species in this habitat group on the GMNF is the limited distribution of the habitat. On the Forest, these habitats generally occur in small, isolated patches because they are at the southern extent of the habitat range on the Forest. Consequently, species associated with this habitat tend to occur in small, isolated populations on the Forest. For most of the species in this group, the GMNF represents the southern extent of the species' range in Vermont.

Trampling is the primary threat to the dry-mesic heath/meadow alpine communities, especially along trails and on ridges and peaks where hikers go "view seeking." As a result, these communities are at greater risk on "lesser summits," where use and plants are concentrated in a small area, than in areas where habitat occurs away from trails and use sites, or occurs over extensive areas like in the White Mountains of New Hampshire. On the GMNF, these habitats are generally accessible as most are located along the Long Trail and Appalachian Trails, which follow the ridgelines and summits of the Green Mountains. There are some smaller high summits that may be difficult to get to and may harbor other populations of some of these species.

Global warming and air pollution (acid deposition and ozone) may be threats to the dry-mesic heath/meadow alpine system and its sensitive plants, but the threat is likely minor compared to hiking pressures.

#### **Management Direction Pertinent to Alpine and Subalpine Habitat**

Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to sensitive plants within these habitats. There is no species-specific management direction in the revised Forest Plan for the sensitive plants of this habitat group. Because these areas are generally well above 2500' in elevation, they are generally not subject to commercial timber harvesting, and generally have thin to non-existent erosive soils. Consequently, standards and guidelines protecting erosive soils through application of Best Management Practices (BMPs) would apply.

Management direction within the Alpine/Subalpine Special Area applies to this habitat group. This management area is designed specifically to conserve this habitat where it covers a more continuous area along Lincoln Ridge at the northern end of the Forest. Known locations for all of the plants in this group are protected through management area designation as some type of Special Area across all alternatives. Mt. Abraham, which is home to several occurrences of these species, is protected under the alternatives as either an Ecological Special Area (Alternative A), or as part of the Alpine/Subalpine Special Area. In either case the species and habitat at this site are protected as values for which the area is designated. Under all alternatives, the cliffs at Mt. Horrid, which are home to the remaining occurrences of these species, are protected as a candidate Research Natural Area, with the cliffs and associated rare plants identified as values for which the area is designated.

The remaining small patches of habitat occur within several other management areas, depending upon alternative. Most of the high summits and ridgelines of the Green Mountains on the Forest are found within existing Wilderness, are associated with the Appalachian and Long Trail Special Areas, or are part of Remote Backcountry Forest. All of these areas have management direction that conserves TES species and their habitats. Some portions of summits, such as Stratton, Haystack, and Abraham, are under long-term special use permits for alpine skiing, and so fall within the Alpine Ski Area Management Area. These areas generally receive regular and intensive vegetation management to maintain open ski trails. While these areas do offer limited habitat opportunities for some of these species, they do not occur there now, and it is not likely that these plants could establish long-term populations in these areas. Consequently, ski areas are not considered suitable habitat for this analysis.

#### **Potential Management Effects**

##### **Direct and Indirect Effects: Habitat**

Habitat quantity is not likely to change across the alternatives. Loss of habitat for this group may have occurred historically during ski area or tower development, but no additional development is proposed in this habitat under any of the alternatives. Habitat quality may decline slightly across all alternatives. Recreational use of the alpine and subalpine zone can lead to trampling of habitat and reduction suitability. Regardless of management area allocation or Plan direction, the recreational pressures on this habitat on the GMNF are likely to increase over the life of the Plan because of the easy access to it from the Long Trail and Appalachian Trail, and the shift taking place in alpine ski areas to year-round activities. Careful management of these recreational pressures can help maintain and restore the quality of these habitats.

All alternatives provide for protection of TES species and their habitat within the alpine zone, either through the Ecological Special Area designation of Mt. Abraham in Alternative A, or the Alpine/Subalpine Special Area designation of Mt. Abraham under Alternative B-E. Under either designation, controlling the impacts of recreation use at the summit of Mt. Abraham to protect resource values is a high priority. Education about an alpine ethic, and the presence of alpine stewards, would be emphasized in all alternatives, as they have been over the past several years. This should increase the effectiveness of stay-on-the-trail education efforts, thus benefiting these communities and their species by reducing the potential for trampling and other impacts.

Subalpine krummholz defined by ELT 14 is allocated in part to the Long Trail management area along Lincoln Ridge, and in part to existing Wilderness, under Alternative A. The portion associated with Wilderness will be managed for low recreational pressure and protection of resource values, which should help to maintain these habitats. The subalpine krummholz habitat along Lincoln Ridge is expected to decline in quality under this alternative, as the Long Trail management area emphasizes a relatively high level of recreational use. Under Alternatives B-E, the Lincoln Ridge section of habitat is placed within the Alpine/Subalpine Special Area, and will be managed to maintain and restore this habitat. Consequently, a balance between recreational use along the Long Trail and habitat protection will be emphasized, and habitat quality is expected to remain stable.

#### Direct and Indirect Effects: Populations

All populations of sensitive plants known to occur in this habitat fall within a Special Area designation across all alternatives, including either the Ecological Special Area or Alpine/Subalpine Special Area designations. These designations emphasize the maintenance of ecological conditions contributing to long-term viability of these species. However, due to the isolated nature of the habitat, and the existing recreational pressures that are expected to continue, populations will continue to be isolated and vulnerable to loss. In particular, populations of *Agrostis mertensii* and *Vaccinium uliginosum* are particularly small and isolated, *Huperzia appalachiana* is still considered historical and has not been relocated, and *Carex bigelowii*, which is the dominant plant on the summit of Mt. Abraham, is doing poorly across the summit as a whole due to trampling. In an area of the summit where hikers are excluded, populations of *Vaccinium uliginosum* and *Carex bigelowii* show improvement. All alternatives, through these Special Area designations, seek to maintain the viability of these populations while offering recreational opportunities, and encourage monitoring of the well being of these populations to identify when additional constraints on recreational use may be needed. Although habitat is expected to decline under Alternative A, none of the sensitive plants associated with this habitat are currently known from the portion of habitat affected by the Long Trail in Alternative A. Consequently, there are not expected to be any differences among alternatives in maintaining existing populations, impacts are expected to be neutral or beneficial, and the alternatives are not expected to result in a loss of viability. In addition, several sensitive species have strong populations throughout the center of this habitat in the Presidential Range of the WMNF, as well as north along the Green Mountains at Mt. Mansfield. As long as suitable habitat continues to exist on the GMNF, it may be repopulated from source populations on the WMNF and northern Green Mountains (SVE Alpine Plants Panel 2002).

#### Cumulative Effects

The analysis area considered for this habitat group includes the proclamation boundary of the GMNF and Camel's Hump State Forest and Park to the north, which serves as the closest area of habitat linking the Forest to the rest of this habitat in Vermont. The GMNF maintains a very small proportion of this habitat within the Green Mountains of Vermont, as well as in the larger context of alpine habitat within the Northern New England region. However, within the Green Mountains, it provides the southernmost occurrences of habitat and populations, and therefore can be important in anchoring the historical range for these species. Most of the existing alpine habitat within the Green Mountains of Vermont is protected in a conservation designation, and is managed to maintain or restore ecological conditions that help maintain viability. Historical habitat losses to ski area and tower development have been similar off the Forest as on the Forest, and have reduced suitable habitat somewhat.

Current and future activities on the Forest in this habitat are likely to involve maintenance of existing trails, establishment of out-areas to allow habitat recovery, and maintenance of existing tower and ski area facilities and trails. These activities will occur within the context of the Special Area designations associated with this habitat across all alternatives, and are not likely to result in major impacts to habitat or populations. They will continue to present a moderate level of risk to populations that will require continued monitoring and management attention. Potential development of existing ski resorts, both on and off the Forest, to provide four-season activities is expected to bring more people to the alpine zone during all seasons, with the accompanying risks associated with trampling of habitat and populations. These risks as well will require monitoring and adjustment to ensure that populations are not lost.

**Species Determination and Rationale**

The revised Plan and its alternatives may impact individuals, but are not likely to cause a trend toward federal listing or loss of viability for any sensitive plant species associated with this habitat. Mitigation measures to protect sensitive alpine plants and increase public education and awareness of the rare alpine community should minimize impacts in all alternatives. Given the harsh alpine environment, species of this habitat tend to be persistent, even in low numbers; education and restoration efforts over the past several years have demonstrated the ability of the community to recover. However, populations will continue to be small, isolated, and vulnerable due to the limited distribution of habitat. Monitoring and management actions to conserve this habitat and its associated species are key factors in mitigating the effects of recreational use on these populations, and without them these populations are less likely to persist on the GMNF.

**Species of Rock or Cliff Habitat****Habitat Description and Distribution**

These habitats include cliffs, rock outcrops, talus slopes, and rocky ridges. These sites are often classified as boreal cliff or outcrop natural communities when they occur above 2,000 feet in elevation, and temperate cliff or outcrop natural communities when they occur below 2,000 feet in elevation. These habitats are also classified based on whether they tend to be acidic or calcareous in nature, as these differences result in very different plant communities. Sites of rock and cliff habitat that have been identified as important habitat for sensitive plants include Mt. Abraham, Bristol Cliffs, Hat Crown/Silent Cliffs, Moosalamoo West Slope, Bryant Mountain, Burnt Mountain, Rattlesnake Point, Mt. Horrid, Devil's Den, and White Rocks.

The boreal and acidic versions of these habitats tend to be small, widely scattered patches, surrounded by or included in forest of various types. Acidic outcrops and ridges are relatively abundant on the Forest and in its associated ecological subsections, although they don't account for a lot of acres. Cliffs of any type are relatively uncommon, but are also widely scattered across the Forest. While about 37,000 acres or 10 percent of the GMNF is classified as ecological types that have frequent outcrops, only about 1,000 to 3,700 acres, or less than one percent of the Forest, is classified as representing actual outcrops or cliffs. A long, narrow and mostly continuous band of temperate acidic and calcareous rock and cliff habitat occurs along the western edge of the Forest along the Route 7 corridor extending from Bristol to the Massachusetts border. This escarpment also represents the division between two broad ecological provinces, one representing the Appalachian Mountains, of which the Green and Taconic Mountains are a part, and the other representing the Great Lakes and St. Lawrence region, of which the Champlain Valley is a part. Consequently, the escarpment and the mix of acidic and calcareous rocks provide habitat for many species of warmer climates that are rare on the GMNF because they are reaching marginal habitat as they extend from the Champlain Valley up onto the Forest in this area.

Most of the species of concern for the Forest occur in open to semi-open rock and cliff habitats, which may be interspersed among patches of trees. These species also tend to have nutrient and substrate requirements that are very narrow. Wind, fire, natural erosion, and human disturbance affect these habitats, and some species respond positively or negatively to particular disturbances. Many species in this group, particularly along the escarpment, respond positively to any disturbance that maintains an open canopy and limits tree growth.

Table 5-4 shows the 17 RFSS plants that are sensitive on the GMNF with affinities for rock and cliff habitats, including their specific habitat requirements, biological factors that may be important to viability, and numbers on the GMNF. This information is based on literature reviews and discussions with botanists regarding these species, and is documented in species summaries (USDA 2004) and the project file.

Table 5-4: RFSS Plants of Rock or Cliff Habitats and factors affecting their viability			
Species	Habitat Requirements	Biological Factors	Occurrences (extant or historical)
<i>Agrostis mertensii</i>	Peaty or rocky soil of alpine meadows and rocky ledges in the drier, more exposed locations; will sometimes also occur on subalpine bare rock summits.	Effective seed disperser; clonal habit with plants sharing root system and resources	4 extant in VT; 4 extant in the cumulative effects analysis area; 1 extant on the GMNF.
<i>Calamagrostis stricta</i> ssp. <i>inexpansa</i>	Sparsely vegetated limy cliffs and quartzite ledges with consistent water seepage	Asexual reproduction with potential inbreeding risks; clonal spread	3 extant and 1 historical from VT; 2 extant and 1 historical in the cumulative effects analysis area; 1 extant on GMNF
<i>Cardamine parviflora</i> var. <i>arenicola</i>	Open or mostly open, dry, rocky, calcareous exposed ledges and outcrops at low to middle altitudes, with oak and hickory, with thin soils and sparse shrubs and herbs	Annual/biennial, so seed dispersal important	3 extant and 11 historical from VT; 3 extant and 7 historical in the cumulative effects analysis area; 2 extant on GMNF
<i>Carex argyrantha</i>	Open, dry, limy cliffs and ledges in western Vermont	Tends to occur in small patches	5 extant and 3 historical in VT; 5 extant and 2 historical in cumulative effects analysis area; 1 extant on GMNF
<i>Carex foenea</i>	Open or mostly open, dry ledges and fields, gravelly or sandy banks, burnt ground, and damp roadsides; below 2,500' elevation; sparse herbs and no shrubs	Single individual at GMNF extant site; taxonomic confusion regarding historical records	Uncertain records in VT or in cumulative effects analysis area, 1 extant and 1 historical on GMNF
<i>Carex scirpoidea</i>	Calcareous cliffs, ledges, and rocky summits, wet or dry, on thin soils, in half to full sun, primarily at higher elevations within northern hardwood forests	Dioecious – need both male and female plants to produce seed	10 extant in VT; 6 extant in the cumulative effects analysis area; 1 extant on GMNF
<i>Clematis occidentalis</i> var. <i>occidentalis</i>	Generally calcareous substrates, including shallow, well-drained soils, exposed rock and cliffs, and bases of cliffs, within open or partly open oak-dominated forests and woodlands, sometimes rich northern hardwoods; below 2,500' elevation	Possible animal dispersal of seeds	16 extant and 18 historical in VT; 15 extant and 16 historical in the cumulative effects analysis area; 3 extant on GMNF
<i>Cryptogramma stelleri</i>	Cold, moist, sheltered calcareous rocks in soil-filled crevices or moist talus; usually dark and never exposed to wind or sun		9 extant and 34 historical in VT; 9 extant and 28 historical in the cumulative effects analysis area, 2 extant on GMNF

Table 5-4: RFSS Plants of Rock or Cliff Habitats and factors affecting their viability			
Species	Habitat Requirements	Biological Factors	Occurrences (extant or historical)
<i>Draba arabisans</i>	Open or mostly open, dry, calcareous rocks or cliffs, in crevices, with sparse shrubs and herbs, associated with sparse oak, hickory, and pine woodlands, generally below 2,500' elevation	Historical over-collecting by botanists	7 extant and 13 historical in VT; 6 extant and 13 historical in the cumulative effects analysis area; 1 extant on GMNF
<i>Huperzia appalachiana</i>	Open habitats of massive or loose, acidic rocks of the alpine zone; exposed cliffs, talus, boulders, and ledges in the subalpine zone; strong affiliation with wet, seepy microsites; generally above 3000' in the Northeast	Inbreeding from vegetative reproduction; competition from hybrid fir-clubmosses; plant collecting	5 extant and 4 historical in VT and cumulative effects analysis area; 2 historical from GMNF but considered still likely there
<i>Juncus trifidus</i>	Primarily rock crevices of moist to dry alpine meadows; also subalpine cliffs and krummholz; often in association with <i>Carex bigelowii</i> and <i>Vaccinium uliginosum</i> . Sandy and gravelly soils, rock outcrops, dry slopes with excessive drainage, in association with oak and pine woodlands; generally below 1,500' elevation; requires full sun and mineral soil for germination, but will form a forest or woodland type	Establishes at a site by seed but expands vegetatively; heavy seeds distributed by birds	6 extant and 1 historical from VT and cumulative effects analysis area; 1 extant from the GMNF.
<i>Pinus rigida</i>		Prolific seeder	Patches in Champlain and Connecticut River Valleys in VT; unknown number in cumulative effects analysis area; 3 extant on GMNF
<i>Rhodiola (=Sedum)rosea</i>	Large, open, wet, calcareous rocks and cliffs, with some soil but not too deep; sparse vegetation, can be semi-shaded	Dioecious – need both male and female plants to produce viable seed; vegetative reproduction through fragmentation	2 extant in VT; 2 extant in the cumulative effects analysis area; 1 extant on GMNF
<i>Saxifraga paniculata</i> ssp. <i>neogaea</i>	Open, seepy, calcareous cliffs, generally above 2,000' elevation	Vegetative reproduction through stolons; long-lived	5 extant in VT; 4 extant in the cumulative effects analysis area, on GMNF
<i>Selaginella rupestris</i>	Open or partially shaded, warm, dry, rocky habitats, usually on schist or quartzite and occasionally limestone; generally below 2,500' elevation	Asexual reproduction; slow-growing; shallow-rooted	5 extant and 26 historical in VT and in the cumulative effects analysis area; 3 extant on GMNF.
<i>Solidago squarrosa</i>	Open or partially shaded, acidic or calcareous, dry, rocky woods, ledges, and outcrops, generally below 2,500' elevation	Hybridization with <i>Solidago macrophylla</i> ; deer herbivory	2 extant and 23 historical in VT; 2 extant and 20 historical in the cumulative effects analysis area; 1 extant and 1 historical on GMNF

Table 5-4: RFSS Plants of Rock or Cliff Habitats and factors affecting their viability			
Species	Habitat Requirements	Biological Factors	Occurrences (extant or historical)
<i>Woodsia glabella</i>	Wet, partially or fully shaded, boreal, calcareous, cliff/ledge summits or talus	No vegetative reproduction; sexual diploid; small population sizes	15 extant and 3 historical in VT; 10 extant and 3 historical in the cumulative effects analysis area; 1 extant on GMNF

### **Limiting Factors and Threats**

The primary limiting factor associated with this habitat is its distribution, related both to geography and geology. The series of rocky habitats associated with the escarpment is restricted to that landscape on the western edge of the Forest due to geologic events. Likewise, most cliffs and rock outcrops, wherever they occur, are associated with geologic or glacial events that place these habitats within the landscapes where they are. As a practical matter, the distribution of this habitat is controlled by geology, and not by human intervention. While the small outcrop habitats may be considered well distributed, the larger cliff, talus, and escarpment habitats are generally not.

In addition to the physical structure of the habitat, substrate chemistry and soil conditions can also be very limiting, again being driven by underlying geology and soil development processes. Calcareous rocky substrates are generally rare on the GMNF, widely scattered in small narrow bands, while acidic rocky substrates are common. Calcareous substrates are also concentrated along the escarpment, often mixing with acidic substrates. Along the escarpment, it is often the case that suitable habitat will become unsuitable over a short distance due to subtle changes in the underlying chemistry of the rocks.

Direct impact from hikers and rock climbers is the primary threat affecting many species in these habitats, especially species that use cliffs. On rocky ridges and some rock outcrop communities, succession to a closed canopy can limit habitat suitability. Vegetation management activities within or adjacent to the habitat can alter light, temperature, and moisture regimes, either to the detriment or benefit of some species. Fire and other disturbances may contribute to persistence of this habitat and associated species, but run the risk of eliminating rare species or weak populations. Non-native invasive species (NNIS) could affect some occurrences of these habitats, particularly along the escarpment where habitats are in close proximity to existing NNIS sources in the Champlain Valley.

### **Management Direction Pertinent to Rock or Cliff Habitat**

Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to sensitive plants within these habitats. There is no species-specific management direction in the revised Forest Plan for the sensitive plants of this habitat group. Because these areas generally have thin to non-existent erosive soils, they are generally not considered suitable for commercial timber harvesting. Standards and guidelines protecting erosive soils through application of Best Management Practices (BMPs) would apply to other activities in these habitats.

Management direction within the Alpine/Subalpine Special Area, the RNA/cRNA, the Ecological Special Area, Wilderness, White Rocks NRA, and the Green Mountain Escarpment Special Area management areas are relevant to this habitat group. These management areas are designed specifically to conserve ecological conditions of value in these areas. Mt. Abraham, as noted for the Alpine habitat group, is conserved either as an Ecological Special Area (Alternative A) or as part of the Alpine/Subalpine Special Area (the remaining alternatives). This will help to protect and enhance the RFSS populations and habitat in that area. Mt. Horrid and Rattlesnake Point, two cliffs with many of the RFSS plants associated with this group, are protected as a cRNA and as an Ecological Special Area, respectively, under all the alternatives. These designations also recognize the high number of rare plants at these sites and seek to protect and enhance the populations and habitats there. Bristol Cliffs and Hat Crown/Silent Cliffs occur within Wilderness, and White Rocks and Devil's Den occur within the NRA; the rare plant populations

there are protected within these designations. Much of the more temperate, calcareous forms of this habitat occur along the western escarpment. The Green Mountain Escarpment Special Area is designed to use management activities, such as prescribed fire and vegetation management, to ensure that the open nature of the escarpment habitats and their associated species are maintained and not lost to forest succession. Several Ecological Special Areas are also designated along the escarpment for conservation of baseline conditions where management activities will be limited. Management activities in these areas can include protection of TES species and habitats.

### **Potential Management Effects**

#### **Habitat: Direct and Indirect Effects**

There is not expected to be any change in habitat quantity as a result of any of the alternatives. Calcareous rock habitat will continue to be far more limited than acidic rock habitat. Existing rock and cliff habitat is relatively stable, although there are some threats related to succession of open habitat to partially closed habitat over the long term, well beyond the life of the revised Plan. As far as is known there have not been any historical losses of this habitat on the GMNF through activities such as mining or development, and none are expected as a result of any of the alternatives.

While all alternatives maintain existing protections for important known habitats, including Mt. Abraham (Ecological Special Area), Bristol Cliffs (Wilderness), Hat Crown/Silent Cliffs (Wilderness), Rattlesnake Point (Ecological Special Area), Mt. Horrid (cRNA), Devil's Den (NRA), and White Rocks (NRA), Alternatives B-E provide particular emphasis on maintaining and restoring important rock and cliff habitat at Moosalamoo West Slope, Bryant Mountain, and Burnt Mountain, through designation of these areas as part of the Green Mountain Escarpment Special Area. Under Alternative A these three areas are part of the Diverse Forest Use or Diverse Backcountry management area designations. Under either set of designations, rock and cliff-dwelling sensitive species and their associated habitats will be protected. Under the Green Mountain Escarpment Special Area designation, maintenance and restoration of these rock and cliff habitats will be emphasized, which may lead to beneficial impacts for some species.

All alternatives provide options for managing vegetation to maintain rock and cliff habitats. Some of the less intensive management areas, like Remote Backcountry Forest or Ecological Special Areas, generally restrict vegetation management to maintenance or restoration of natural communities and habitat for TES species, while others allow vegetation management for a wide variety of purposes. Under either circumstance, vegetation management can be targeted to maintain the open conditions many of the species affiliated with this habitat need to persist. Vegetation management can also cause negative impacts, such as increasing competition from NNIS, which will be mitigated by Forest-wide and management area specific guidance on control of NNIS.

All alternatives allow prescribed fire and/or wildland fire use to achieve resource objectives or desired management area conditions across management areas. These conditions could include limiting forest succession in these habitats, improving habitat quality. Given the small amount of prescribed fire done each year, the low natural fire interval, the scattered distribution of this habitat and lightning-ignited fires, and the small size of wildland fires expected, fire use may not alter much of this habitat on the Forest. However, prescribed fire could be used to specifically to maintain habitat for sensitive species, providing beneficial impacts to this habitat and potentially to species.

All alternatives tend to limit some activities that cause ground-disturbance in these habitats. Rock habitats do not provide the best sites for developed, backcountry, or dispersed camping sites, and most rock habitats are considered unsuitable for timber harvesting or road building due to logistical challenges. Non-native invasive species (NNIS) are often associated with these activities, and so risks from NNIS are also minimized due to the nature of these habitats.

Hiking use is expected to increase in all alternatives. Therefore the potential for trampling of plants is expected to increase. Trail building, which can lead to smaller scale degradation of habitat quality, is limited only in RNA/cRNA and Remote Wildlife management areas. The remaining management areas



all provide similar risks associated with trail construction, maintenance, and use, particularly trampling and destruction of populations. These impacts can be mitigated by Forest-wide protections for erosive soils and for sensitive species and their habitats, as well as monitoring to determine if use levels are degrading habitat and impacting populations. Forest Service policy allows for constraints on use levels to prevent the loss of viability of sensitive species.

#### Populations: Direct and Indirect Effects

All known populations of sensitive plants associated with this habitat, except for *Pinus rigida*, are in designations across all alternatives where intensity of management is generally low. These designations include cRNA, Ecological Special Area, Wilderness, and White Rocks NRA. All of these designations emphasize protection of unique resource values, including sensitive plants and their habitats, that are associated with the designations, and in some cases are the reasons for their designation. These designations also allow management as needed to maintain habitat for sensitive species. The effect of these designations on existing populations of sensitive plants will be to help maintain ecological conditions that contribute to long-term species viability.

Due to the isolated nature of the habitat, suppression of natural disturbance regimes, and existing recreational pressures that are expected to continue, populations in these habitats will continue to be isolated and vulnerable to loss. This is particularly true for *Carex argyrantha*, *Huperzia appalachiana*, and *Pinus rigida*, all of which are expected to become more at risk over the next 20 years, regardless of alternative (USDA 2004). All alternatives seek to maintain the viability of these populations while offering recreational opportunities, and encourage monitoring of the well being of these populations to identify when additional constraints on recreational use may be needed. Consequently, there are not expected to be any differences among alternatives in maintaining existing populations, impacts are expected to be minor, and the alternatives are not expected to cause losses of viability. Some populations may benefit from targeted management actions to improve habitat conditions.

For *Pinus rigida*, populations of this species are known from parts of the escarpment that are managed under Alternative A as Diverse Forest Use or Diverse Backcountry, and under Alternatives B-E as Green Mountain Escarpment Special Area. Under any of these management areas, vegetation management is allowed, and has the potential to cut individuals, reduce seed sources, and encourage competition from NNIS and other plants. Vegetation management within these areas can also be used as a tool to facilitate reproduction of this species by removing competing vegetation, providing light to the ground, and preparing a seedbed. The Green Mountain Escarpment Special Area emphasizes management to maintain and restore these habitats and species. While the remaining management areas do not emphasize these habitats, forest-wide guidance for sensitive species and associated habitat will tend to mitigate the negative impacts and foster the potential beneficial impacts of vegetation management in these areas. Consequently, impacts to *Pinus rigida* are expected to be minor, possibly beneficial, and implementation of any of the alternatives is not likely to cause a loss of viability.

#### Cumulative Effects

Within the Green and Taconic Mountains of Vermont, the GMNF manages no more than a quarter of the lands in which these habitats are likely to be found, although the Forest does manage several important sites for this habitat that are considered of state-wide significance. Specific plans for new hiking and summer motorized trails, climbing areas, or residential development are not known in this habitat for the GMNF, or for the mountainous region of Vermont. Development within ski resorts is likely to occur as these areas try to expand their operations throughout the year, and may impact small amounts of this habitat. It is also likely that rural and urban development will continue to expand within the region, and some of it could eliminate suitable rock habitat. Increased use of hiking trails, ATVs, and rock climbing may occur outside the Forest, and could result in impacts to species of concern or their habitat if species occur at popular sites. Due to the dominance of schistose rock in the Green Mountains and shale and slate in the Taconics, rock climbing does not occur at high intensities in Vermont. Invasive species are also increasing on non-Forest lands within the proclamation boundary and in the region, and are likely to continue to expand. This expansion increases the risk of invasion by NNIS of rock habitats on and off the Forest.

Perhaps the largest potential impact to these habitats is the development of high elevation areas for wind and communication towers. Generally this development is not likely to occur along the spine of the Green Mountains due to public concerns and the presence of the Appalachian and Long Trails in this area. The tops of smaller mountains and hills could provide opportunities for this type of development, although the rock and cliff habitat that would be affected in these areas is likely to be much smaller. Development of this type can eliminate suitable habitat for sensitive species if they occur in those areas.

Impacts that could reduce or eliminate off-Forest populations of sensitive species, and thereby alter the ability of Forest populations to interact with these populations, could lead to a reduction in the ability of Forest populations to recover from direct and indirect effects noted above, as well as from random natural disturbance events like rock slides or wind storms. Given that several of the species affiliated with this habitat group are known from only one or two places on the Forest and so engender concerns regarding genetic isolation and loss from such random events, as well as the potential for direct, indirect, and cumulative effects discussed here, the viability of some species may decline regardless of alternative chosen.

#### **Species Determination and Rationale**

The revised Plan and its alternatives may impact individuals, but are not likely to cause a trend toward federal listing or loss of viability for any sensitive plant species associated with this habitat. Protection of known occurrences in protective designations and through project mitigation measures, and maintenance and restoration of habitat, should minimize negative impacts under all alternatives. However, populations will continue to be small, isolated, and vulnerable due to the limited distribution of habitat. Monitoring and management actions to conserve this habitat and its associated species are key factors in mitigating the effects of recreational use and other activities on these populations, and without them some species are less likely to persist on the GMNF.

### **Species of Barrens and Open Uplands**

#### **Habitat Description and Distribution**

Habitats included in this group are fields, meadows, woods edges, thickets, and some cultural habitats such as roadsides, utility corridors, and old gravel pits. In Vermont, these habitats are generally not considered a long-term natural community, but rather of a temporary nature. They may occur as a result of natural or human-caused disturbances, or they may occur naturally in small areas of poor habitat that cannot support trees. For this analysis, open habitats that occur on rock outcrops, talus and cliffs are discussed above for Rock and Cliff habitats; the habitats discussed here, then, do not occur on rocks, although they may be associated with rocky areas. Likewise, open wetland habitats are discussed as a separate group below, and so habitats discussed here are not wetlands, although they can be moist. There are no sites identified on the Forest of barren or open upland habitat that are considered significant ecologically or for rare species. However, several sites where species affiliated with this habitat have been found are identified as important, including Rattlesnake Point, Burnt Hill, Bryant Mountain, Moosalamoo West Slope, and Mt. Horrid.

On the GMNF, these habitats generally occur as small patches widely scattered across the Forest. They tend to span the elevation gradient, although they are generally restricted to zones below subalpine (open areas within the subalpine zone are usually on rock outcrops). Because these habitats are formed by a variety of disturbances, they can be well distributed. However, within this broad habitat group many species have microhabitat preferences such as soil chemistry or texture, or warm temperatures, which are not as well distributed. The species in this category are strongly associated with open conditions, and so the gaps in forests that will support them need to be large enough to meet their needs for high amounts of light. Natural disturbances associated with these habitats include fire, wind, and ice loading. In addition to historical and more recent upland openings that are maintained as old fields by the GMNF, timber-harvesting activities also commonly create this habitat in association with skid roads and log landings, which are abandoned after use but remain suitable for several years.

Table 5-5 shows the six RFSS plants that are sensitive on the GMNF with affinities for barren and open upland habitats, including their specific habitat requirements, biological factors that may be important to viability, and numbers on the GMNF. This information is based on literature reviews and discussions with botanists regarding these species, and is documented in species summaries (USDA 2004) and the project file.

<b>Table 5-5: RFSS Plants of Barren and Open Upland Habitats and factors affecting their viability</b>			
<b>Species</b>	<b>Habitat Requirements</b>	<b>Biological Factors</b>	<b>Occurrences (extant or historical)</b>
<i>Carex foenea</i>	Open or mostly open, dry ledges and fields, gravelly or sandy banks, burnt ground, and damp roadsides; below 2,500' elevation; sparse herbs and no shrubs	Single individual at GMNF extant site	Uncertain records in VT or in cumulative effects analysis area, 1 extant and 1 historical on GMNF
<i>Lespedeza hirta</i>	Dry, sandy or rocky, open woodlands, fields, thickets, and woods edges, associated with oak-pine-hardwood woodlands; generally below 1,500'		3 extant and 3 historical in VT; 2 extant and 3 historical in the cumulative effects analysis area; 1 extant adjacent to GMNF
<i>Pinus rigida</i>	Sandy and gravelly soils, rock outcrops, dry slopes with excessive drainage, in association with oak and pine woodlands; generally below 1,500' elevation; requires full sun and mineral soil for germination, but will form a forest or woodland type	Prolific seeder	Patches in Champlain and Connecticut River Valleys in VT; unknown number in cumulative effects analysis area; 3 extant on GMNF
<i>Sisyrinchium angustifolium</i>	Consistently moist soils and open habitats, including moist meadows, stream banks, swamp edges, sandy meadows, moist open woods, low woods, thickets, and damp shores; usually acidic	No vegetative reproduction	13 extant and 16 historical in VT; 12 extant and 9 historical in cumulative effects analysis area; 4 extant on GMNF
<i>Sisyrinchium atlanticum</i>	Moist or dry meadows, swales, marshes, low woods, preferring open sites at low to mid-elevations	Short-lived	1 extant and 9 historical in VT; 1 extant and 5 historical in the cumulative effects analysis area; 1 extant on GMNF
<i>Solidago squarrosa</i>	Open or partially shaded, acidic or calcareous, dry, rocky woods, ledges, and outcrops, generally below 2,500' elevation	Hybridization with <i>Solidago macrophylla</i> ; deer herbivory	2 extant and 23 historical in VT; 2 extant and 21 historical in the cumulative effects analysis area; 1 extant and 1 historical on GMNF

**Limiting Factors and Threats**

The primary limiting factors for this habitat are the requirement for high amounts of sunlight, and the temporary nature of the habitat. Both factors are related and indicate that the stability and distribution of this habitat on the Forest may be limited. While generally well distributed, these habitats lose suitability quickly as openings experience forest succession, which is the dominant ecological process in these habitats. In rare cases, this will happen at very long time scales and so is less of a concern. However, with succession to forest being the dominant process most likely associated with these habitats, species may be lost without management to delay succession. Open habitat can also form naturally through regular and repeated fire, insects, disease, flooding, and tree damage from wind and ice. Loss or control of some of these factors can also lead to succession to forest in these habitats.

For some species, substrate chemistry and texture limits the distribution of suitable habitat. Calcareous, sandy, and gravelly substrates are rare on the Forest, and tend to be limited to river valleys and the escarpment. Acidic, rocky, and moist substrates are far more common and well distributed.

Threats to the habitat can come from several sources. Fire and logging can both be used to create habitat, but they may also damage small or weak populations. Trampling and disturbance from hiking and trail development can also create small areas of habitat, while at the same time increasing risk of trampling to small or weak populations. NNIS are often associated with open, disturbed habitats, and are often more competitive and aggressive than native species in these habitats.

**Management Direction Pertinent to Barrens and Open Uplands Habitat**

Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to sensitive plants within these habitats. There is no species-specific management direction in the revised Forest Plan for the sensitive plants of this habitat group. Some of these areas have thin, erosive soils, and so standards and guidelines protecting erosive soils through application of Best Management Practices (BMPs) would apply. Forest-wide standards and guidelines prohibit off-road use of motorized or mechanized vehicles, and saddle, pack and draft animals, and provide abundant guidance on maintaining permanent openings for wildlife. These guidelines generally limit the creation of new habitat to 30 acres patches or smaller.

The maintenance and creation of open or partially open (woodland) habitat is encouraged or allowed in the following management areas: Diverse Forest Use, Diverse Backcountry Forest, Remote Wildlife Habitat, Green Mountain Escarpment, White Rocks National Recreation Area, Appalachian Trail, Long Trail, Recreation Special Areas, Alpine Ski /Ski Area Expansion Areas, and Eligible Scenic and Recreational Rivers. The remaining management areas restrict most openings to natural processes, unless needed to maintain habitat or populations of a TES species.

**Potential Management Effects****Habitat: Direct and Indirect Effects**

Most management areas allow for the maintenance and creation of upland openings, at least to maintain habitat for occurrences of TES species. Consequently, it is likely that all alternatives will provide an adequate amount of this habitat well distributed across the Forest. Under Alternatives B through E, at least 92 percent of existing upland openings will be allocated to management areas where their maintenance is allowed; under Alternative A, about two-thirds of the existing openings are allocated to these management areas. While this habitat is generally well distributed, the sensitive species affiliated with this habitat are far rarer than the habitat itself, likely because they are associated with a very specific set of conditions within this habitat, such as calcareous substrates, coarse sandy or gravelly substrates, warmer climates, or some other as yet undetermined set of conditions. Because the quantity of natural openings caused by poor site conditions is quite limited on the Forest, as is the quantity of openings with calcareous or coarse substrates, the alternatives are not likely to affect the relative extent of these characteristics on the Forest. However, the open character of these conditions can be affected by alternatives.

Half of the species associated with this habitat group are found on the GMNF only along the escarpment, and west into the Vermont and Champlain Valleys. This habitat is characterized by rocky or coarse substrates, often with limestone or dolomite, and warmer conditions than in the Green Mountains. Across alternatives, portions of the escarpment that are not already allocated to White Rocks NRA or Wilderness are allocated primarily to Diverse Forest Use, Diverse Backcountry, or the Green Mountain Escarpment Special Area. Under all alternatives, over half of the escarpment landscape is within management areas that allow creation and maintenance of openings, and the remaining half are within areas that would allow some limited vegetation management if needed to maintain populations of TES species. All alternatives are therefore likely to maintain the needed habitat for species affiliated with this habitat in the escarpment.

Under all alternatives, vegetation management can be targeted to maintain the open conditions required by the species affiliated with this habitat, leading to beneficial impacts such as increased habitat availability and improved conditions for reproduction and germination. Vegetation management can also cause negative impacts, such as increasing competition from NNIS, which will be mitigated by Forest-wide and management area specific guidance on prevention and control of NNIS. Logging can have direct impacts on the habitat through road building, skidding logs, and compaction of soil. However, logging roads and landings have become suitable habitat for some species in this group.

Prescribed fire is a common tool used to maintain existing wildlife openings, along with mowing. Fires were also likely to maintain some of these habitats historically, particularly along the escarpment. All alternatives allow prescribed fire and/or wildland fire use to achieve resource objectives or desired management area conditions across management areas. These conditions include limiting forest succession in openings, improving habitat quality, providing beneficial impacts to this habitat and potentially to species.

Trail use by hikers as well as motorized vehicles is increasing, and the increased pressure of recreational use and trail construction can have direct impacts on this habitat (see the Recreation section). None of the alternatives specify a level of trail construction desired over the next 15 years, and construction of new trails will be based on demonstrated demand and site-specific analyses. The level of new trail construction is therefore not likely to vary by alternative, although the types of uses may vary. Most alternatives allow the development of new motorized trails on about half of the Forest, with the largest proportion under Alternative B at 64 percent, and the least under Alternative D at 41 percent. While pressures on this habitat from recreational use may therefore be slightly higher under Alternative B, Forest-wide standards and guidelines for TES protection will mitigate most impacts. The edges of these trail corridors can become suitable habitat for some of these species over time if they are open enough.

All alternatives limit the use of motorized and mechanized vehicles to trails and roads. However, damage by ORV use could affect this habitat group because open habitats are often desirable places in which to ride. Such riding can directly impact populations and can damage habitat through rutting and compaction of soils. Agency policy allows for constraints on recreational use, including area closures, if uses are damaging resources, including habitats for TES species.

#### Populations: Direct and Indirect Effects

Of the six species in this group, two (*Carex foenea* and *Solidago squarrosa*) are currently known to occur only once on or adjacent to the Forest, in areas that are protected across all alternatives. These protective designations will ensure that ecological conditions needed by the species are maintained to contribute to long-term viability.

Another two species (*Lespedeza hirta* and *Pinus rigida*) occur along the escarpment in areas that are allocated to either Diverse Forest Use (Alternative A) or Green Mountain Escarpment Special Area (Alternatives B-E). These second two species are easy to identify and are not likely to be overlooked during searches. These two species are also not likely to occur outside the escarpment on the Forest, and so they are only likely to be impacted by activities in this landscape. Under either management area, vegetation management is allowed, and has the potential to damage individuals, reduce seed sources by harvesting mature pitch pine, and encourage competition from NNIS and other plants. Vegetation

management within these areas can also be used as a tool to facilitate reproduction by removing competing vegetation, providing light to the ground, and preparing a seedbed. The Green Mountain Escarpment Special Area emphasizes management to maintain and restore these habitats and species. While the remaining management areas do not emphasize these habitats, forest-wide guidance for sensitive species and associated habitat will tend to mitigate the negative impacts and foster the potential beneficial impacts of vegetation management in these areas. Consequently, impacts to these species are expected to be minor or possibly beneficial, not leading to a loss of viability.

The two *Sisyrinchium* species are known from roadsides, woods roads, and moist openings, habitats that are very common on the Forest. It is unclear why these species appear much less common than the available habitat, although they are considered overlooked by most botanists (SVE Open Rocks Plants Panel 2002). However, recent searches have suggested that identification of *S. angustifolium* may rely on population rather than individual characteristics, and as a result several recent potential populations were determined to be the more common species. In any case, none of the alternatives is likely to eliminate or reduce this type of habitat on the Forest to any extent that could be predicted to lead to greater concerns for these species.

For *Carex foenea*, *Lespedeza hirta*, and *Solidago squarrosa*, their low population numbers and isolated occurrences, as well as increasing recreational pressures, will continue to leave them vulnerable to loss. All alternatives seek to maintain the viability of these populations while offering recreational opportunities, and encourage monitoring of the well being of these populations to identify when additional constraints on recreational use may be needed. Consequently, there are not expected to be any differences among alternatives in maintaining existing populations, impacts are expected to be minor, and the alternatives are not expected to result in a loss of viability. Some populations may benefit from targeted management actions to improve habitat conditions.

#### Cumulative Effects

The cumulative effects analysis area for this habitat includes the GMNF proclamation boundary, the Champlain and Vermont Valleys, and the Taconic Mountains, which serve as a source of propagules for most of the species that occur in these habitats along the western side of the Forest. This is a unique group of plants, most of which can be found in unnaturally disturbed habitats as well as more natural areas such as edges and sand plains, but all of which appear rare or vulnerable to loss. Human disturbances may only mimic natural events like wind-throw and fire, but may not fully replicate the effects of those disturbances. There is little information on why these species are rare if they can tolerate disturbance, although the proximity to a seed source, timing of disturbance relative to a good seed year, and exposure of mineral soil are known to be important for *Pinus rigida*. These conditions may coincide only rarely, and similar conditions may be a requirement for other species in this group.

The distribution of these species historically is generally scattered across Vermont, with concentrations in the Champlain and Vermont Valleys. For known existing populations, the GMNF holds between one third and one half of the population in Vermont for three of the species, and holds the only known record in Vermont of another. Open habitat with moderate levels of disturbance is abundant, although much recent disturbance in the Champlain Valley has been residential and commercial development with habitat loss. Habitat conditions may become more suitable on the GMNF over time than off the Forest because of the increasing development, and these conditions have the potential on the Forest to be more stable than off-Forest. However, this increasing disparity between habitat conditions on and off the Forest may further isolate many of these populations, leading to declines over the long term. As with many rare species, little is known about the needs of most of these species, and it is difficult to predict their population trends. Under all alternatives, the Forest will conduct site monitoring, attempt to control NNIS, and conduct management to maintain populations of these species and their habitats.

#### Species Determination and Rationale

The revised Plan and its alternatives may impact individuals, but are not likely to cause a trend toward federal listing or loss of viability for any sensitive plant species associated with this habitat. Protection of known occurrences in protective designations, project mitigation measures, and maintenance and

restoration of habitat, should minimize negative impacts under all alternatives. However, populations of several species in this group will continue to be small and isolated, and may be vulnerable due to the limited distribution of particular habitat conditions or the timing of disturbance events with good seed years. Monitoring and management actions to conserve this habitat and its associated species, and create opportunities for reproduction, are key factors in mitigating the effects of recreational use and lack of historical disturbance regimes on these populations; without them some species of this habitat are less likely to persist on the GMNF.

## **Species of Aquatic Habitats**

### **Habitat Description and Distribution**

This habitat includes permanent waterbodies (ponds, lakes, rivers, streams) of various sizes, elevations, and conditions with respect to water quality and chemistry. This habitat includes both the deep water and the littoral zones, but not areas that may dry out during natural, late summer, draw down periods or summer drought. Habitats that are under water for certain periods of time but may become exposed during late summer are discussed under Shore Habitats below. Areas with aquatic habitat that have been identified as ecologically significant and provide habitat for RFSS include Abbey Pond, Skylight Pond, Lefferts Pond, Kent Pond, Wallingford Pond, Little Rock Pond, Big Mud Pond, Griffith Lake, Moses Pond, Mud Pond, Little Mud Pond, Bourn Pond, Branch Pond, Beebe Pond, Grout Pond, Little Pond, Crystal Pond, Old Rte 9 Pond, Camp Casino Pond, Sucker Pond, as well as parts of Otter Creek, Blue Banks Brook, Dutton Brook, North Branch Middlebury River, Winhall River, Red Mill Brook and Stamford Stream. Several other ponds within the Proclamation Boundary are also considered important aquatic habitats for rare aquatic plants.

The headwaters of many streams and rivers are located on the GMNF, and many first and second order headwater streams for the major watersheds in southern Vermont originate in the GMNF (Donna 2004). Most streams on the Forest are headwater streams, although near the edges are some larger streams. The Forest tends to be bounded in places by major rivers like the White, West, Otter, and Deerfield, but these rivers rarely occur within the Proclamation Boundary of the Forest except for their headwaters. A number of lakes and ponds occur on the Forest, predominantly within the southern portion of the Forest at mid to high elevations. A number of high elevation ponds and headwater streams on the Forest are considered of high quality as reference areas in Vermont (Thompson 2002).

Headwater streams on the Forest tend to have steep slopes, narrow streambeds with large boulders, and dense, forested riparian area vegetation. On flatter landforms like benches and the broader plateaus, such as in the Lye Brook area, these small streams can become marshy with low gradients and slow water movement. The few larger streams on the Forest tend to be associated with broader valleys that may have a mix of open meadows and wetlands with forested vegetation. The suitability of aquatic habitats for particular species varies with such factors as size, depth, temperature, acidity, and adjacent vegetation. Generally, the headwater streams on the GMNF have higher levels of aluminum, lower levels of base cations, and lower pH primarily due to the type of bedrock and higher precipitation levels (Donna 2004). The valley bottom streams on the Forest tend to have lower levels of aluminum, and increased levels of base cations and pH. It is also well documented that GMNF and other Vermont streams experience a reduction of pH, alkalinity, and calcium during spring runoff in mid to late April. Some streams have lost floodplain and riparian connection (through deepening), have widened, and have become more shallow, and warm, which can reduce the quality or suitability of these streams for rare species.

Ponds on the Forest tend to occur at higher elevations, and occur within a forested setting with a mix of coniferous and deciduous forest vegetation. Many of the high elevation ponds have associated wetland habitats that provide additional sites for rare plants. Some ponds have been acidified due to atmospheric deposition, although they vary in terms of their buffering capacity and levels of aluminum toxicity (Donna 2004). Some ponds, like Branch and Bourne Ponds, contain high levels of dissolved organic matter that gives the water a "tea-stained" color. These dissolved organic compounds can help reduce aluminum toxicity to fish and invertebrates. In contrast, clear water acid ponds are more likely to have toxic levels of

free aluminum. Other ponds on the Forest, such as Wallingford Pond, exhibit greater buffering capacity because of higher alkalinity in surrounding soils.

Table 5-6 shows the 10 RFSS plants that are sensitive on the GMNF with affinities for aquatic habitats, including their specific habitat requirements, biological factors that may be important to viability, and numbers on the GMNF. This information is based on literature reviews and discussions with botanists regarding these species, and is documented in species summaries (USDA 2004) and the project file.

<b>Table 5-6: RFSS Plants of Aquatic Habitats and factors affecting their viability</b>			
<b>Species</b>	<b>Habitat Requirements</b>	<b>Biological Factors</b>	<b>Occurrences (extant or historical)</b>
<i>Isoetes tuckermanii</i>	Quiet, shallow water of slightly acidic oligotrophic lakes, ponds, and streams, with stable water levels, sandy bottoms, and high light, generally below 2,200' elevation.	Vegetative reproduction through fragmentation; seeds dispersed by waterfowl	1 extant and 7 historical in VT; 1 extant and 4 historical in cumulative effects analysis area; none confirmed on GMNF; no longer considered likely
<i>Myriophyllum farwellii</i>	Still, soft water of slightly acidic oligotrophic ponds, bogs, and slow streams, generally on muddy or soft bottoms, generally at high elevations	Waterfowl and animals disperse seeds and vegetative structures	14 extant and 4 historical in VT; 3 extant and 2 historical in cumulative effects analysis area; 1 extant and 3 unconfirmed on GMNF
<i>Myriophyllum humile</i>	Acidic to neutral waters of clear, softwater, oligotrophic lakes and ponds on sandy to mucky substrates, or sandy, muddy, or peaty shores of such waterbodies, generally below 2,500' elevation	Vigorous vegetative reproduction; has a terrestrial form during low water; highly inbred with low to no heterozygosity; considerable doubts regarding identification of any of the VT records as this species.	5 extant in VT; 4 extant in cumulative effects analysis area; none confirmed on GMNF; no longer considered likely
<i>Plantago</i> (=Littorella) <i>americana</i>	Shallow water or exposed sunny shorelines of slightly acidic ponds, whose water levels may fluctuate, on sand and gravel substrates, generally above 1,000' elevation; needs draw-down to flower	Waterfowl disperse seeds; extensive vegetative reproduction; has mycorrhizal associations	13 extant and 1 historical in VT; 3 extant in cumulative effects analysis area; 2 extant on GMNF
<i>Potamogeton bicupulatus</i>	Shoreline or littoral zone of quiet acidic softwater lakes and ponds on sandy, muck, or rocky substrates	Prolific seeder; seeds dispersed by waterfowl	9 extant in VT; 5 extant in cumulative effects analysis area; 1 extant on GMNF
<i>Potamogeton confervoides</i>	Quiet, nutrient-poor, strongly acidic waters of ponds or lakes with muddy, well-vegetated shores, on sandy to peaty substrates	Extensive vegetative reproduction; seeds dispersed by animals; persistent seedbank	13 extant in VT; 9 extant in cumulative effects analysis area; 8 extant on GMNF
<i>Potamogeton hillii</i>	Clear, cold, quiet, alkaline, shallow waters of small streams, ponds, and beaver ponds with muddy substrates	Prolific fruiter; dispersed by waterfowl; generally not persistent and behaves as a ruderal species	45 extant and 4 historical in VT; 24 in cumulative effects analysis area; none confirmed on GMNF



Table 5-6: RFSS Plants of Aquatic Habitats and factors affecting their viability			
Species	Habitat Requirements	Biological Factors	Occurrences (extant or historical)
<i>Sparganium fluctuans</i>	Quiet, cold, slightly acidic, soft waters of oligotrophic lakes, ponds, and rivers, generally at higher elevations, on muddy, oozy substrates	Prolific fruiter; seeds dispersed by waterfowl; vegetative reproduction	26 extant and 6 historical in VT; 15 extant and 1 historical in cumulative effects analysis area; 10 extant on GMNF
<i>Utricularia geminiscapa</i>	Quiet, acidic to moderately alkaline waters of pools, ponds, bogs, and sluggish streams; needs draw-down to flower	Vegetative reproduction; no roots – acquires nutrients through leaves; carnivorous	25 extant in VT; 11 extant within cumulative effects analysis area; 10 extant on GMNF
<i>Utricularia resupinata</i>	Shallow, clear, soft acid waters of lakes and ponds, or exposed sandy, muddy, or peaty shores of ponds and bogs; needs draw-down to flower	Rarely flowers; carnivorous	7 extant and 1 historical in VT; 1 extant and 1 historical in cumulative effects analysis area; 1 extant on GMNF

### **Limiting Factors and Threats**

The primary limiting factors affecting species in this habitat group are the distribution of suitable habitat, and the water quality of existing suitable habitat. Headwater streams, both marshy and rocky, are relatively abundant and well-distributed across the Forest. On the other hand, larger streams are generally restricted to the edges of the Forest, primarily because some of them formed convenient boundaries for Forest administration at the time the Proclamation Boundary was designated for the GMNF. Consequently, very little large stream habitat, both of the midreach type with well-defined, alternating patterns of pool, riffle, and run, and the main channel type that is large, quiet, and deep with no riffles, is available on the Forest. Ponds are generally restricted on the Forest to the southern portion, where the landscape has less topographic relief and is more conducive to the formation of ponds. In addition, while examples of naturally dystrophic (“tea-stained” as noted above), high elevation acidic, and mesotrophic/eutrophic (more nutrient enriched) ponds exist on the Forest, there are few examples of the larger oligotrophic lakes on the Forest. The GMNF does include portions of three reservoirs, Harriman, Somerset, and Chittenden, although none appear to offer suitable habitat at this time for the plant RFSS in this habitat group.

Of the various types of ponds on the Forest, most of those that provide suitable habitat for aquatic RFSS have been identified and were noted earlier. These ponds vary in several attributes, which can naturally limit the suitability of these habitats for certain species. While most are acidic, there is some variability in levels of acidity, and some species prefer different parts of the acidity to alkalinity spectrum. The condition of the substrate also varies across these ponds, with some being sandy or rocky, and others being muddy or organic. Again, some species prefer one type of substrate over another. Another factor that can limit suitability is the stability of the water level. Most species in this group prefer stable water levels, and so that is why beaver ponds are generally not considered suitable habitat. However, some species require a lowering of the water level once a year or so in order to flower. This may happen naturally through late summer droughts, or through beaver activity.

A major threat to water quality on the GMNF is atmospheric deposition, which is being monitored and analyzed very closely in select areas. Streams and ponds vary in their productivity, levels of acidity, and their ability to neutralize toxicity and buffer acidity. It is uncertain whether atmospheric deposition is changing water chemistry enough to limit habitat suitability for the species in this habitat group, as most are associated with acid conditions.

Development, changes to hydrology, runoff and pollution, human use, and NNIS are the primary threats facing plant RFSS in aquatic habitats. In recent decades, rural, urban, and recreational development of aquatic habitat has altered water quality, water quantity, and adjacent habitat, making many places unsuitable for some species. Development can eliminate riparian habitat and alter water quality and quantity. Roads, trails, dams, and other management can alter hydrology and change channel and lakeshore conditions, making habitat more or less suitable for some species. They also form barriers to movement of some species, as well as facilitating water quality problems from run-off, pollution, human use, and NNIS. Sedimentation and pollution alter water quality and streambed conditions. Water withdrawal reduces water quantity, while other human uses result in disturbance and changes to habitat conditions. Roads and trails provide corridors for movement of invasive species into aquatic systems; NNIS can alter aquatic and riparian vegetation and water chemistry. While the effects of rural, urban, and major recreational development tend to be limited to the edges of the GMNF, beaver activity and vegetation and trail management can still affect water quality and aquatic habitat suitability in similar ways.

#### **Management Direction Pertinent to Aquatic Habitats**

Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to sensitive plants within these habitats. There is no species-specific management direction in the revised Forest Plan for the sensitive plants of this habitat group. Because these are aquatic habitats, resource protection measures in the revised Plan that protect water quality would apply. Resource protection measures include minimizing ground-disturbance and tree removal within protective buffers adjacent to aquatic habitats; construction of stream crossings that maintain water flows; restricting use of heavy equipment and other activities to minimize erosion and sedimentation; and ensuring that servicing and refueling of equipment happens outside protective buffers.

Management direction within the Ecological Special Areas, Wilderness, White Rocks NRA, Remote Backcountry Forest, and Wilderness Study Area, are applicable to these habitats because a majority of the identified important aquatic habitats occur within these areas across all alternatives. All of these areas provide emphasis and guidance on protecting habitat for TES species, and prohibit or limit many ground disturbing activities that can lead to potential water quality degradation. In addition, Eligible Wild Rivers also provide similar protections and emphasis as these areas, although they currently are not known to harbor rare plants. Management direction for the remaining management areas also provides protections for TES species.

#### **Potential Management Effects**

##### **Habitat: Direct and Indirect Effects**

The quantity of habitat is not expected to change under any of the alternatives, as there are not management activities that are proposed or expected to create or destroy lakes, ponds, streams, or rivers. A majority of the ponds and portions of the streams identified as sensitive plant habitat are allocated to protected designations under all alternatives, or at least under Alternatives B through E. Forest-wide standards and guidelines mitigate most remaining impacts to those ponds and streams identified as important habitats, as well as other ponds and streams that may provide suitable habitat.

Timber harvesting can result in sedimentation and run-off from roads, introduction of pollutants and waste, and loss of soil anchoring vegetation under any of the alternatives. It can also alter the temperature and shading of aquatic habitat if shoreline trees are removed. Trail construction and recreational use adjacent to ponds and streams can have similar impacts. Forest-wide standards and guidelines for protecting water quality noted above will limit tree removal along the shores, and will limit ground-disturbing and polluting activities near aquatic habitats. Riparian zone buffers will be maintained in order to ensure that water quality is not degraded. Consequently, most impacts will be mitigated, or will be minor.

Across alternatives, water withdrawals and stream impoundments for municipal uses or ski areas can alter the hydrology of an area and reduce natural water levels. One of the ponds noted above as significant for sensitive plants serves as a municipal water source. Under all alternatives, water levels

and in-stream flows documented in agreements will be maintained, so withdrawals and impoundments should not negatively impact existing sensitive species. Impoundments created by beaver can and do cause impacts to these habitats by raising and lowering water levels, which have negative consequences for most species in this habitat group. Because all alternatives provide for protection of habitat for TES species, beaver activity can be controlled through removal of dams and through other structures that limit their ability to raise water levels above a desirable point. Beaver activity can impact plants before monitoring has detected a problem, and so these impacts may still occur, leading to potential declines in populations.

Management guidance for fisheries habitat management under all alternatives seeks to restore stream ecosystems to meet natural stream potential and provide a sustainable fishery. Some habitat management activities require in-stream activities such as placement of structures and moving boulders, which have the potential to damage sensitive plants associated with a stream. However, habitat management would be required to adhere to Forest-wide standards and guidelines and agency policy for protecting TES species, and so impacts are expected to be minimal. It is uncertain if habitat restoration has the potential to improve habitat conditions for some sensitive plants of these habitats.

Recreational access to waterbodies and streams can act as a vector for NNIS, such as Eurasian water milfoil or water chestnut. While these species are not currently known to occur in waterbodies on the Forest, they occur outside the Forest, and can be transported via boats, trailers, and vehicles from one waterbody to another. These species can grow rapidly, shading out other aquatic plants, changing water chemistry, and altering food webs. Most ponds considered important habitats are not directly accessible via motorized access, which may in part explain the lack of infestation to date. Standards and guidelines for NNIS prevention and control in all habitats should reduce the potential for indirect impacts to habitats and species. In addition, standards and guidelines limiting activities near streams should reduce the potential for introduction of NNIS to aquatic habitats. However, because aquatic habitats most susceptible to infestation also typically have fragmented ownerships, activities on adjacent private lands can contribute to new infestations on federal lands in spite of application of management guidance in the revised Plan.

Additional motorized access to the Forest in general can increase the risk of bringing trails closer to these habitats, resulting in illegal off-trail use, user-created trails, and the associated impacts, including decreases in water quality and introduction of NNIS. None of the alternatives specify a level of trail construction desired over the next 15 years, and construction of new trails will be based on demonstrated demand and site-specific analyses. The level of new trail construction is therefore not likely to vary by alternative, although the types of uses may vary. Most alternatives provide opportunities for the development of new motorized trails (snowmobiles or summer ORV) on about half of the Forest, with the largest proportion under Alternative B at 70 percent, and the least under Alternative D at 47 percent. While risks to this habitat from potential new motorized access may therefore be slightly higher under Alternative B, Forest-wide standards and guidelines for water quality and TES protection will mitigate most impacts. Consequently, these slight differences among alternatives are not likely to cause a loss of viability for species in this habitat group.

#### Populations: Direct and Indirect Effects

Most species in this habitat group have all or most of their populations on the GMNF in protected designations across all alternatives. *Isoetes tuckermanii* and *Myriophyllum humile*, currently sensitive species, are no longer considered likely to occur on the GMNF based on botanical inventories in 2003 and review of old records; previous records of these species were determined to have been misidentified (Jenkins 2003). *Potamogeton hillii* is known from within the proclamation boundary near the Forest, but is more likely to be affected by activities off the Forest than by any activities on the Forest in that area. *Potamogeton confervoides*, *Sparganium fluctuans*, and *Utricularia geminiscapa* have several populations on the GMNF, and between 75 to 80 percent of them are in protected areas. All three species also appear to be doing well on the GMNF, and their populations are expected to remain stable (SVE Aquatic Plants Panel 2002).

Most species in this habitat group are known to be sensitive and vulnerable to water quality degradation and water level fluctuations, particularly *Utricularia resupinata*, which will flower only during a late summer lowering of water levels, and is only known from one site, which is protected. Several populations of species in this group are associated with ponds that have developed or dispersed camping around them; some species in this group also have historical records from these same ponds, but have not been relocated there. However, only *Utricularia resupinata* is considered to be at moderate risk, while the other species appear to be doing well in spite of these risks (SVE Aquatic Plants Panel 2002). A combination of protective designations and water quality standards and guidelines, along with required monitoring and adjustments in management, will contribute to the maintenance of ecological conditions needed for long-term viability of the species in this habitat group.

#### Cumulative Effects

The cumulative effects analysis area for sensitive species in this group includes all of the 12-digit subwatersheds that encompass the GMNF proclamation boundary. Using subwatersheds to define the area of analysis works best for these species because they are strongly associated with water and hydrological processes. Of the species in this group that are known to occur on the GMNF, the Forest generally holds a small proportion of the statewide populations except for *Potamogeton confervoides*, *Sparganium fluctuans*, and *Utricularia geminiscapa*. However, the Forest does hold most of the populations of the species in this group known to occur within the subwatersheds that comprise the GMNF proclamation boundary. For *Potamogeton hillii*, populations off the Forest are likely more important as the Forest provides very marginal habitat for it.

Lakes and rivers outside National Forest ownership are vulnerable to development, sedimentation, and shoreline damage. Increasing levels of development off the Forest are likely to result in changes in vegetation along lakeshores, alteration of hydrology supporting these habitats, degradation of water quality, increased access by motor vehicles to aquatic habitats, and increases in infestation by NNIS. Several ponds and many streams on the Forest have only partial federal ownership. Protection of RFSS plants can be difficult in these situations because activities associated with aquatic habitats are determined by the multiple ownerships, although state regulation of watercraft and state BMPs for water quality would apply. Many aquatic habitats have already been affected by these activities historically, and state regulations and BMPs may help to limit impacts of future activities on habitat or populations. However, development and recreational pressures on desirable aquatic habitats are likely to continue off the Forest. All of these potential impacts make the GMNF, with its low levels of lakeshore development, and generally low levels of recreational development, an important source of undisturbed lake and pond habitat for species of this group. Since Forest-wide management guidance should minimize impacts from management activities, the GMNF would continue to provide high quality aquatic habitat within the Green Mountains, and likely some of the best habitat within the GMNF subwatersheds for species in this group.

#### Species Determination and Rationale

The revised Plan and its alternatives may impact individuals, but are not likely to cause a trend toward federal listing or loss of viability for any sensitive plant species associated with this habitat. Protection of known occurrences in protective designations, project mitigation measures that prevent or minimize water quality degradation, and management of recreational uses along shores and motorized access to shores, should minimize negative impacts under all alternatives. However, populations of several species in this group will continue to be vulnerable to changes in water quality and water levels due to beaver activities, potential infestations of NNIS, and illegal motorized access to ponds. Monitoring and management actions to conserve this habitat and its associated species are key factors in mitigating the effects of beaver activities and recreational use on these populations; without them some species of this habitat are less likely to persist on the GMNF.

### **Species of Shore Habitat**

#### Habitat Description and Distribution

Shore habitat includes the land adjacent to lakes, ponds, rivers, and streams that is influenced by the water. The species discussed here are those associated with the shoreline or very shallow water on

shorelines where fluctuating water levels are more common. This habitat can occur along ponds as well as along streams, and so the distribution of this habitat is similar to that discussed for aquatic habitats. Many ponds and streams noted above include some of these shore species; some of these species are associated with wetland habitats, which are described later in this chapter.

Shore habitats on the Forest also vary in terms of their physical, biological, and chemical attributes, similar to the aquatic habitats. Because the species in this group are generally in contact with the water source, they tend to segregate as aquatic species do, based on preferences for certain habitat attributes, such as levels of acidity or alkalinity, conductivity, water depth, temperature, and light, as well as other attributes, like shoreline stability. While there are some shorelines on the Forest that are naturally erosive, most if not all of the shoreline habitat considered suitable for the rare plants in this group is relatively stable. However, where shoreline habitat is in association with river systems, the flooding and ice-scouring dynamics of these systems can also be important for rare plants. Many shore species found along rivers require fairly open substrates, and rely on river dynamics to continue to create new habitats.

Table 5-7 shows the 14 RFSS plants that are sensitive on the GMNF with affinities for shore habitats, including their specific habitat requirements, biological factors that may be important to viability, and numbers on the GMNF. This information is based on literature reviews and discussions with botanists regarding these species, and is documented in species summaries (USDA 2004) and the project file.

<b>Table 5-7: RFSS Plants of Shore Habitats and factors affecting their viability</b>			
<b>Species</b>	<b>Habitat Requirements</b>	<b>Biological Factors</b>	<b>Occurrences (extant or historical)</b>
<i>Carex aquatilis</i> var. <i>substricta</i>	Calcareous waters, pond edges, marshes, medium and rich fens, and ditches, preferring neutral or calcareous soils and open habitat, generally below 3,300' elevation; tolerates variable hydrology; benefits from regular flooding	Strong vegetative reproduction forming large mats	10 extant and 8 historical in VT; 6 extant and 4 historical in cumulative effects analysis area; 3 extant on GMNF
<i>Carex lenticularis</i> var. <i>lenticularis</i>	Open, wet shores of rivers, ponds, lakes, and bogs, in acidic to neutral waters, on exposed soils; adapted to varied levels of water; generally below 3,000' elevation; needs flooding to disperse seeds and facilitate germination		7 extant and 3 historical in VT; 4 extant and 2 historical in cumulative effects analysis area; 3 extant in GMNF
<i>Carex michauxiana</i>	Cold, wet conditions in bogs, floating bog mats, oligotrophic pond margins, and wet meadows, on acid peats and wet sands, generally above 2,200 feet in elevation		5 extant and 3 historical in VT; 3 extant and 2 historical in cumulative effects analysis area; 3 extant in GMNF
<i>Eleocharis intermedia</i>	Along stream margins, marshy ground, and mud flats, on open, wet, calcareous, soft peat or mud soils, usually with a few shrubs and abundant sedges, generally below 2,500' elevation; associated with dynamic river systems	Is an annual, so seed dispersal important	11 extant and 5 historical in VT; 7 extant and 2 historical in cumulative effects analysis area; 2 extant on GMNF

Table 5-7: RFSS Plants of Shore Habitats and factors affecting their viability			
Species	Habitat Requirements	Biological Factors	Occurrences (extant or historical)
<i>Geum laciniatum</i>	Moist or wet soils of circumneutral pH, along open river shores, roadsides, meadows, shrub swamps, thickets, and woods edges, in open or mostly open conditions, generally below 1,500'	Vegetative reproduction; animal dispersal of seeds;	11 extant and 3 historical in VT; 5 extant and 2 historical in cumulative effects analysis area; 4 extant on GMNF
<i>Muhlenbergia uniflora</i>	Open, wet, sandy or peaty, shores, bogs, swales, and roadsides, often associated with beaver meadows systems or disturbed areas		4 extant and 6+ historical in VT; 4 extant and 1 historical in cumulative effects analysis area; 4 extant on GMNF
<i>Myriophyllum humile</i>	Acidic to neutral waters of clear, softwater, oligotrophic lakes and ponds on sandy to mucky substrates, or sandy, muddy, or peaty shores of such waterbodies, generally below 2,500' elevation	Vigorous vegetative reproduction; has a terrestrial form during low water; highly inbred with low to no heterozygosity; considerable doubts regarding identification of any of the VT records as this species.	5 extant in VT; 4 extant in cumulative effects analysis area; none confirmed on GMNF; no longer considered likely
<i>Peltandra virginica</i>	Shallow water or mud of open margins of bogs, ponds, streams, damp meadows, floodplain forests, swamps, and marshes, in slightly acid to alkaline conditions, generally below 2,500' elevation	Limited vegetative reproduction; dispersal limited	8 extant and 3 historical in VT; 3 extant and 2 historical in cumulative effects analysis area; 1 extant on GMNF.
<i>Plantago</i> (=Littorella) <i>americana</i>	Shallow water or exposed sunny shorelines of slightly acidic ponds, whose water levels may fluctuate, on sand and gravel substrates, generally above 1,000' elevation; needs draw-down to flower	Waterfowl disperse seeds; extensive vegetative reproduction; has mycorrhizal associations	13 extant and 1 historical in VT; 3 extant in cumulative effects analysis area; 2 extant on GMNF
<i>Polemonium vanbruntiae</i>	Wet, seepy, circumneutral soils of open to partially open wetlands, shores, wet woods, and ditches, generally below 2,000'	Vigorous vegetative reproduction; restricted to one county in VT; isolated from closest populations in NY and ME	9 extant in VT; 8 extant in cumulative effects analysis area; 7 extant on GMNF
<i>Potamogeton bicupulatus</i>	Shoreline or littoral zone of quiet acidic softwater lakes and ponds on sandy, muck, or rocky substrates	Prolific seeder; seeds dispersed by waterfowl	9 extant in VT; 5 extant in cumulative effects analysis area; 1 extant on GMNF
<i>Scheuchzeria palustris</i>	Calcareous bogs and peaty shores of marshes, ponds, and lakes, under minerotrophic conditions, generally below 2,500', with stable hydrology	Vegetative reproduction; sporadic in abundance	5 extant and 12 historical in VT; 1 extant and 9 historical in cumulative effects analysis area; 1 extant and 3 historical on GMNF

Table 5-7: RFSS Plants of Shore Habitats and factors affecting their viability			
Species	Habitat Requirements	Biological Factors	Occurrences (extant or historical)
<i>Torreyochloa pallida</i> var. <i>fernaldii</i>	Wet edges of wetlands, beaver meadows, floating bog mats, and high elevation ponds, in full or partial sun, generally below 3,500'		7 extant and 3 historical in VT; 4 extant in cumulative effects analysis area; 4 extant on GMNF
<i>Utricularia resupinata</i>	Shallow, clear, soft acid waters of lakes and ponds, or exposed sandy, muddy, or peaty shores of ponds and bogs; needs draw-down to flower	Rarely flowers; carnivorous	7 extant and 1 historical in VT; 1 extant and 1 historical in cumulative effects analysis area; 1 extant on GMNF

### **Limiting Factors and Threats**

The primary limiting factors affecting species in this habitat group, as for aquatic species, are the distribution of suitable habitat, and the quality of existing suitable habitat. Shoreline habitat has similar distribution constraints as aquatic habitat, including restriction of larger, more dynamic streams to the Forest edges, and ponds and lakes to the southern portion of the Forest. Shores of wetlands and headwater streams are more widely distributed across the Forest, although wetlands and small marshy headwater streams are also more concentrated in the southern portion.

Habitat quality and suitability for shore species is limited by both the types of attributes noted for aquatic species, such as acidity, conductivity, temperature, light, elevation, and substrates, as well as the stability of the shoreline in terms of water fluctuation, flooding, and scouring. Some shore species, like *Scheuchzeria palustris*, are associated with stable water levels in peatland types of ecosystems, while others, like *Eleocharis intermedia*, rely on flooding and ice scour to maintain open, sparsely vegetated, mineral soil riparian habitat in which to establish and spread. Some shore species, such as *Muhlenbergia uniflora*, seem to be associated with habitats that tend to be beaver influenced.

Shoreline development, changes to hydrology and river dynamics, changes to shoreline light and vegetation cover, changes in water quality, and invasive exotic species are the primary threats facing species of riparian habitats. Activities that can affect riparian habitats include damming, deepening, or straightening the flow of streams and rivers, rip-rapping of river shores, vegetation management, timber harvest, camping, shoreline recreation (such as fishing), stream habitat restoration, and construction, maintenance, and use of trails and roads. Private management activities, such as river flow management, agricultural use, development, and vegetation management, can contribute to habitat suitability and quality problems in adjacent riparian habitat on National Forest.

### **Management Direction Pertinent to Shore Habitat**

Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to sensitive plants within these habitats. There is no species-specific management direction in the revised Forest Plan for most of the sensitive plants of this habitat group. Specific guidance for *Polemonium vanbruntiae* includes protection measures for roadside populations. Because these are riparian habitats, resource protection measures in the revised Plan that protect water quality and riparian areas would apply. Resource protection measures include minimizing ground-disturbance and tree removal within protective buffers adjacent to aquatic habitats; construction of stream crossings that maintain water flows; restricting use of heavy equipment and other activities to minimize erosion and sedimentation; and ensuring that servicing and refueling of equipment happens outside protective buffers. Standards and guidelines for Fisheries also apply, which provide guidance on restoration activities and the use of native materials and native stock.

Management direction within the Ecological Special Areas, Wilderness, White Rocks NRA, Remote Backcountry Forest, and Wilderness Study Area, are applicable to these habitats because a majority of the identified important aquatic habitats noted earlier, including those with shore species, occur within these areas across all alternatives. All of these areas provide emphasis and guidance on protecting habitat for TES species, and prohibit or limit many ground disturbing activities that can lead to potential water quality degradation. In addition, Eligible Wild Rivers also provide similar protections and emphasis as these areas, including emphasis on existing RFSS that were important values associated with the rivers. Management direction for the remaining management areas also provides protections for TES species.

***Potential Management Effects******Habitat: Direct and Indirect Effects***

The quantity of habitat is not expected to change under any of the alternatives, as there are not management activities that are proposed or expected to create or destroy lakes, ponds, streams, or rivers, or their shoreline habitat. A majority of the ponds and portions of the streams identified as sensitive plant habitat are allocated to protected designations under all alternatives, or at least under Alternatives B through E. Forest-wide standards and guidelines mitigate most remaining impacts to those ponds and streams identified as important habitats, as well as other ponds and streams that may provide suitable habitat.

Timber harvesting can result in sedimentation and run-off from roads, introduction of pollutants and waste, trampling of shoreline plants, and changes in riparian vegetation under any of the alternatives. It can also alter the temperature and shading of shoreline habitat if trees are removed, to the benefit of some species and the detriment of others. Trail construction and recreational use adjacent to ponds and streams can have similar impacts. Forest-wide standards and guidelines for protecting water quality noted above will limit tree removal along the shores, and will limit ground-disturbing and polluting activities near aquatic habitats. Riparian zone buffers will be maintained in order to ensure that water quality is not degraded. Forest-wide guidance for protection of TES habitat will ensure that vegetation quality needed by these species is maintained. Consequently, most impacts will be mitigated, or will be minor.

Across alternatives, water withdrawals and stream impoundments for municipal uses or ski areas can alter the hydrology of an area, reduce natural water levels, and change river dynamics by reducing flooding and scouring of shorelines. Impoundments created by beaver can have similar effects. These activities can significantly change shoreline habitat, making it less suitable for some species and more suitable for others. Under all alternatives, water levels and in-stream flows documented in agreements will be maintained, so withdrawals and impoundments should not negatively impact existing sensitive species. Because all alternatives provide for protection of habitat for TES species, beaver activity can be controlled through removal of dams and through other structures that limit their ability to raise water levels above a desirable point. Beaver activity can impact plants before monitoring has detected a problem, and so these impacts may still occur, leading to potential declines in some populations.

Management guidance for fisheries habitat management under all alternatives seeks to restore stream ecosystems to meet natural stream potential and provide a sustainable fishery. Some habitat management activities require disruption of shorelines, either to access the stream for in-stream activities, or to anchor in-stream structures. Forest-wide standards and guidelines emphasize the use of native materials for restoration work, which will help prevent the establishment of NNIS in these habitats lead to more effective ecological restoration. These activities, as well as any resulting changes in flows, have the potential to damage sensitive plants associated with a stream shoreline. However, habitat management would be required to adhere to Forest-wide standards and guidelines and agency policy for protecting TES species, and so impacts are expected to be minimal. It is uncertain if habitat restoration has the potential to improve habitat conditions for some sensitive plants of these habitats.

Recreational access to waterbodies and streams can act as a vector for NNIS that use shore habitats, such as purple loosestrife or Japanese knotweed. NNIS of shore habitats currently occur most frequently



off the Forest, although they have been found along some major rivers along the edges of the Forest, and they can be transported via boats, trailers, and vehicles from one aquatic habitat to another. These species can grow rapidly, shading out other shoreline plants, changing hydrologic patterns, and altering food webs. Most ponds considered important habitats are not directly accessible via motorized access, which may in part explain the lack of infestation of ponds to date. Recreational access to streams on the Forest for boating and fishing is more common along the larger streams, which are also beginning to experience infestations of NNIS. Standards and guidelines for NNIS prevention and control in all habitats should reduce the potential for indirect impacts to habitats and species. In addition, standards and guidelines limiting activities near streams should reduce the potential for introduction of NNIS to riparian areas. However, because the types of stream habitats most susceptible to infestation in the GMNF area are the larger streams where federal ownership is quite fragmented, activities on adjacent private lands can contribute to new infestations on federal lands in spite of application of management guidance in the revised Plan.

Additional motorized access to the Forest in general can increase the risk of bringing trails closer to shoreline habitats, resulting in illegal off-trail use, user-created trails, and the associated impacts, including degradation of shore habitat and introduction of NNIS. None of the alternatives specify a level of trail construction desired over the next 15 years, and construction of new trails will be based on demonstrated demand and site-specific analyses. The level of new trail construction is therefore not likely to vary by alternative, although the types of uses may vary. Most alternatives provide opportunities for the development of new motorized trails on about half of the Forest, with the largest proportion under Alternative B at 70 percent, and the least under Alternative D at 47 percent. While risks to this habitat from potential new motorized access may therefore be slightly higher under Alternative B, Forest-wide standards and guidelines for water quality and TES protection will mitigate most impacts. Consequently, these slight differences among alternatives are not likely to cause a loss of viability for species in this habitat group.

#### Populations: Direct and Indirect Effects

About half of the species in this habitat group have all or most of their populations on the GMNF in protected designations across all alternatives. These designations provide ecological conditions that are likely to contribute to the long-term viability of these species. *Myriophyllum humile*, currently a sensitive species, is no longer considered likely to occur on the GMNF based on botanical inventories in 2003 and review of old records; previous records of this species were determined to have been misidentified (Jenkins 2003). *Carex lenticularis*, *Polemonium vanbruntiae*, and *Torreyochloa pallida* var. *fernaldii* all have at least one population within a protected designation, while *Geum laciniatum* and *Peltandra virginica* have none of their populations in protected designations. *Polemonium vanbruntiae*, which is a globally rare species, occurs frequently on the Forest along roadsides, and so the revised Plan provides additional protection for these occurrences, which are vulnerable to roadside mowing and road maintenance work. Forest-wide management guidance for protection of TES species and water quality should mitigate potential impacts to these five species.

While none of the species in this habitat group are expected to decline substantially over the next 15-20 years, several have low population numbers or additional vulnerabilities that warrant concern. Some, like *Carex lenticularis* or *Eleocharis intermedia*, require open shore habitat that is vulnerable to succession or flooding by beaver. Several species, like *Carex aquatilis*, *Eleocharis intermedia*, *Peltandra virginica*, and *Scheuchzeria palustris* require calcareous shore habitat as well, which is rare on the Forest, so their opportunities are limited. *Peltandra virginica* also is reaching the northern extent of its range on the Forest, and has a single population along a shoreline that is only partially within federal ownership. *Utricularia resupinata* will flower only during a late summer lowering of water levels, and is only known from one site. These species are considered to be at moderate risk, while the other species appear to be doing well in spite of the risks they face in this habitat (SVE Aquatic Plants Panel 2002, SVE Open/Nonforested Wetland Plants Panel 2002; SVE Forested Wetlands Plants Panel 2002). A combination of protective designations and water quality standards and guidelines, along with required monitoring and adjustments in management, will contribute to the maintenance of ecological conditions needed for long-term viability of the species in this habitat group.

### Cumulative Effects

The cumulative effects analysis area for sensitive species in this group includes all of the 12-digit subwatersheds that encompass the GMNF proclamation boundary. Using subwatersheds to define the area of analysis works best for these species because they are strongly associated with water and hydrological processes. None of these shoreline species have more than 20 occurrences documented in the state. Of the species in this group that are known to occur on the GMNF, the Forest generally holds less than half of the statewide populations except for *Carex michauxiana*, *Muhlenbergia uniflora*, *Polemonium vanbruntiae*, and *Torreyochloa pallida* var. *fernaldii*. However, for most species in this group, the Forest does hold most of the populations known to occur within the 63 subwatersheds that comprise the GMNF proclamation boundary.

Shores of lakes and rivers outside National Forest ownership are vulnerable to development, sedimentation, and shoreline damage. Increasing levels of development off the Forest are likely to result in changes in vegetation along lakeshores, alteration of hydrology supporting these habitats, degradation of water quality, increased access by motor vehicles to shore habitats, and increases in infestation by NNIS. Several ponds and many streams on the Forest have only partial federal ownership. Protection of RFSS plants can be difficult in these situations because activities associated with shore habitats are determined by the multiple ownerships, although state regulation of watercraft and state BMPs for water quality would apply. Many shore habitats have already been affected by these activities historically, and state regulations and BMPs may help to limit impacts of future activities on habitat or populations. However, development and recreational pressures on desirable aquatic habitats are likely to continue off the Forest, affecting the shorelines of these places. All of these potential impacts make the GMNF, with its low levels of lakeshore development, and generally low levels of recreational development, an important source of undisturbed riparian habitat for species of this group. Since Forest-wide management guidance should minimize impacts from management activities, the GMNF would continue to provide high quality aquatic habitat within the Green Mountains, and likely some of the best habitat within the GMNF subwatersheds for species in this group.

Off-Forest impacts could reduce or eliminate populations and thereby alter metapopulation dynamics, especially for those species associated with shores of rivers and streams. Most species are recovering from the effects of intensive habitat changes in past decades or centuries, including effects to shore habitat from logging and log-drives, dams, and agriculture. While some off- and on-Forest activities may impact these habitats in the next 20 years, these effects will be negligible compared to declines resulting from past harvests, land conversions, and water flow regulation. Stream habitat restoration, especially done in partnership with adjacent landowners, as is recommended in the revised Plan, may also help to reverse some of the historical declines in shore habitat, possibly benefiting species as well.

### Species Determination and Rationale

The revised Plan and its alternatives may impact individuals, but are not likely to cause a trend toward federal listing or loss of viability for any sensitive plant species associated with this habitat. Protection of known occurrences in protective designations, project mitigation measures that prevent or minimize water quality degradation, vegetation management to protect shoreline vegetation and manage for habitat needs, and management of recreational uses along shores and motorized access to shores, should minimize negative impacts under all alternatives. However, populations of several species in this group will continue to be vulnerable to changes in water quality and water levels due to beaver activities, potential infestations of NNIS, illegal motorized access to ponds, and losses due to small single populations on the Forest. Monitoring and management actions to conserve this habitat and its associated species are key factors in mitigating the effects of beaver activities, management actions, and recreational use on these populations; without them some species of this habitat are less likely to persist on the GMNF.

## Species of Open Wetlands

### Habitat Description and Distribution

This habitat encompasses open wetlands of a variety of sizes and types, such as beaver meadow complexes, shrub swamps, peatlands, sedge meadows, wet upland meadows, and roadside ditches. Open wetlands associated with shores of streams and ponds share some of the same species as the Shore habitat group. Areas with open wetland habitat, or with RFSS associated with this habitat, that have been identified as ecologically significant include Fifield Pond, Stamford Stream Wetland Complex, Stamford Meadows, Thendara Camp Fen, Lye Brook Headwaters, Branch Pond, Beebe Pond, Somerset Fen, Winhall River Headwaters Flowage, Little Mud Pond, Griffith Lake, Little Rock Pond, Lost Pond Bog, Mt. Tabor Work Center Swamp, Wallingford Pond, Blue Ridge Fen, Skylight Pond, Dutton Brook Swamp, and Beaver Meadows/Abbey Pond.

Open wetlands, and wetlands in general, are concentrated within the low hill, low slope, plateau, and valley landscapes of the Forest. These landscapes are more prominent in the southern portion of the Forest, although they are also common in the western portion of the northern half of the Forest. National Wetland Inventory maps show over 3,300 acres of open and scrub-shrub wetlands on the GMNF, averaging a little over three acres in size, and ranging from less than an acre to 41 acres. This constitutes less than one percent of National Forest System lands. A recent survey identified approximately 650 open wetlands in the southern half of the Forest, and approximately 200 on the northern half (Williams 1996). Most open wetlands on the GMNF are associated with rivers and are influenced by recent beaver activity; few are old and stable wetlands like peatlands.

The open wetland habitat group provides for a wide variety of wetland habitat conditions. Within this group, species often have specific habitat requirements primarily associated with water quality, water chemistry, climate, elevation, physiography, light levels, atmospheric deposition, previous land use, and beaver activity. Most open wetlands on the Forest are acidic, but the rare occurrences of calcium-enriched wetlands tend to harbor most of the rare plants of this group. Other plants are strongly associated with peatlands, particularly fens, which are also quite rare on the Forest. Jenkins (1981) suggests that many rare plants associated with wetlands require wetlands that are stable and have developed over long periods of time. Some open wetland species can exploit atypical wetlands created by historic and current land management patterns, such as wet roadside ditches, wet upland meadows, and open wet log landings and woods roads.

Table 5-8 shows the 14 RFSS plants that are sensitive on the GMNF with affinities for open wetland habitats, including their specific habitat requirements, biological factors that may be important to viability, and numbers on the GMNF. This information is based on literature reviews and discussions with botanists regarding these species, and is documented in species summaries (USDA 2004) and the project file.

<b>Table 5-8: RFSS Plants of Open Wetland Habitats and factors affecting their viability</b>			
<b>Species</b>	<b>Habitat Requirements</b>	<b>Biological Factors</b>	<b>Occurrences (extant or historical)</b>
<i>Blephilia hirsuta</i>	Calcium- and nutrient-enriched woodland seeps and wet edges of enriched northern hardwoods, swamp forests, floodplains, and wet meadows, generally below 2,500' elevation	Insect pollinated; vegetative reproduction; edge of range	4 extant and 4 historical in VT; 3 extant and 1 historical in cumulative effects analysis area; 3 extant on GMNF

Table 5-8: RFSS Plants of Open Wetland Habitats and factors affecting their viability			
Species	Habitat Requirements	Biological Factors	Occurrences (extant or historical)
<i>Carex aquatilis</i> var. <i>substricta</i>	Calcareous waters, pond edges, marshes, medium and rich fens, and ditches, preferring neutral or calcareous soils and open habitat, generally below 3,300' elevation; tolerates variable hydrology; benefits from regular flooding	Strong vegetative reproduction forming large mats	10 extant and 8 historical in VT; 6 extant and 4 historical in cumulative effects analysis area; 3 extant on GMNF
<i>Carex atlantica</i>	Shrub and sedge-dominated swamps and bogs, generally acidic or with calcareous seepage; generally below 2,500' elevation	Long-lived and persistent	4 extant in VT; 2 extant in the cumulative effects analysis area; none confirmed on GMNF; no longer considered likely on GMNF
<i>Carex michauxiana</i>	Cold, wet conditions in bogs, floating bog mats, oligotrophic pond margins, and wet meadows, on acid peats and wet sands, generally above 2,200 feet in elevation		5 extant and 3 historical in VT; 3 extant and 2 historical in cumulative effects analysis area; 3 extant in GMNF
<i>Carex schweinitzii</i>	Open and forested wetlands where groundwater seeps over limestone bedrock, including cedar swamps, red maple-tamarack swamps, and edges of fens and wet meadows	Globally rare; strong vegetative reproduction; forms extensive colonies	15 extant and 4 historical in VT; 11 extant and 4 historical in cumulative effects analysis area; 1 extant on GMNF
<i>Cypripedium reginae</i>	Restricted to calcareous wetlands, including fens, cedar swamps, red maple-tamarack swamps, shrubby edges of wooded swamps; generally below 1,500'	Pollinated by insects; low flowering and low seed viability; vegetative reproduction; 15 years to flower; dependent on soil mycorrhizae	69 extant and 18 historical in VT; 16 extant and 17 historical in cumulative effects analysis area; 3 extant on GMNF
<i>Eleocharis intermedia</i>	Along stream margins, marshy ground, and mud flats, on open, wet, calcareous, soft peat or mud soils, usually with a few shrubs and abundant sedges, generally below 2,500' elevation; associated with dynamic river systems	Is an annual, so seed dispersal important	11 extant and 5 historical in VT; 7 extant and 2 historical in cumulative effects analysis area; 2 extant on GMNF
<i>Geum laciniatum</i>	Moist or wet soils of circumneutral pH, along open river shores, roadsides, meadows, shrub swamps, thickets, and woods edges, in open or mostly open conditions, generally below 1,500'	Vegetative reproduction; animal dispersal of seeds;	11 extant and 3 historical in VT; 5 extant and 2 historical in cumulative effects analysis area; 4 extant on GMNF

Table 5-8: RFSS Plants of Open Wetland Habitats and factors affecting their viability			
Species	Habitat Requirements	Biological Factors	Occurrences (extant or historical)
<i>Muhlenbergia uniflora</i>	Open, wet, sandy or peaty, shores, bogs, swales, and roadsides, often associated with beaver meadows systems or disturbed areas		4 extant and 6+ historical in VT; 4 extant and 1 historical in cumulative effects analysis area; 4 extant on GMNF
<i>Polemonium vanbruntiae</i>	Wet, seepy, circumneutral soils of open to partially open wetlands, shores, wet woods, and ditches, generally below 2,000'	Vigorous vegetative reproduction; restricted to one county in VT; isolated from closest populations in NY and ME	9 extant in VT; 8 extant in cumulative effects analysis area; 7 extant on GMNF
<i>Scheuchzeria palustris</i>	Calcareous bogs and peaty shores of marshes, ponds, and lakes, under minerotrophic conditions, generally below 2,500', with stable hydrology	Vegetative reproduction; sporadic in abundance	5 extant and 12 historical in VT; 1 extant and 9 historical in cumulative effects analysis area; 1 extant and 3 historical on GMNF
<i>Sisyrinchium angustifolium</i>	Consistently moist soils and open habitats, including moist meadows, stream banks, swamp edges, sandy meadows, moist open woods, low woods, thickets, and damp shores; usually acidic	No vegetative reproduction	13 extant and 16 historical in VT; 4 extant and 6 historical in cumulative effects analysis area; 4 extant on GMNF
<i>Sisyrinchium atlanticum</i>	Moist or dry meadows, swales, marshes, low woods, preferring open sites at low to mid-elevations	Short-lived	1 extant and 6 historical in VT; 1 extant and 4 historical in the cumulative effects analysis area; 1 extant on GMNF
<i>Torreyochloa pallida</i> var. <i>fernaldii</i>	Wet edges of wetlands, beaver meadows, floating bog mats, and high elevation ponds, in full or partial sun, generally below 3,500'		7 extant and 3 historical in VT; 4 extant in cumulative effects analysis area; 4 extant on GMNF

### **Limiting Factors and Threats**

Primary limiting factors associated with this habitat include its distribution and quality. While open wetlands in general are well distributed across the Forest, with a higher concentration in the southern portion of the Forest, calcareous wetlands and peatlands of any type are quite rare, known from small isolated areas on both the northern and southern portions of the Forest. Calcareous wetlands tend to be restricted to areas of calcareous bedrock or till, which are more common in the Champlain and Vermont Valleys, and restricted to the escarpment and small narrow bands widely scattered across the Forest. Peatlands, which require hundreds of years to develop, are very rare on the Forest. Compartment data indicate less than 30 peatlands on the Forest, and Williams' (1996) sample of 4 of these peatlands indicated that 50 percent were not actually true peatlands with deep peat development.

Habitat quality tends to be limited by the amount of disturbance affecting the wetland. Some species are associated with disturbed conditions and/or regular cycles of disturbance caused by flooding, scouring, and beaver, while other species require stable hydrology. Beaver are most likely the principle drivers in physical and vegetation changes to the ecology of most open wetlands. Williams (1996), in his study of wetlands on the GMNF, indicated that the majority of wetlands on the Forest are riverine, that beaver

influenced all riverine wetlands sampled, and that 65 percent of the wetlands sampled indicated fairly recent beaver activity.

There are several threats that can eliminate or degrade open wetland habitats. Development and agriculture can eliminate open wetland habitat and alter water quality and quantity. Roads, trails, dams, and other management in or near wetlands can change the local hydrology, making habitat more or less suitable for some species. Wet ditches, culverts, and compacted soils of woods roads can sometimes develop into suitable habitat for some species. Succession of open wetlands to forested wetlands can eliminate habitat for many species of concern. NNIS can invade open wetlands and out-compete native species, including rare plants, as well as change ecosystem processes in wetlands. Beaver activity can also alter local hydrology and can flood wetlands that otherwise have stable hydrology, eliminating habitat for rare plants. Activities permitted under the revised Forest Plan that can affect riparian habitats include vegetation management, and construction, maintenance, and use of trails and roads.

#### **Management Direction Pertinent to Open Wetland Habitat**

Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to sensitive plants within these habitats. There is no species-specific management direction in the revised Forest Plan for most of the sensitive plants of this habitat group. Specific guidance for *Polemonium vanbruntiae* includes protection measures for roadside populations. Open wetland habitats are protected by water quality and riparian area guidance found in the revised Plan. Resource protection measures include minimizing ground-disturbance and tree removal within protective buffers adjacent to wetland habitats; avoiding wetlands during stream crossings; restricting use of heavy equipment and other activities to minimize erosion and sedimentation; ensuring that servicing and refueling of equipment happens outside protective buffers; restricting use of wetlands for roads and trails; and avoiding brush piling in open wetlands.

Management direction within RNA/cRNAs, Ecological Special Areas, Wilderness, White Rocks NRA, and Remote Backcountry Forest, are applicable to these habitats because a majority of the identified important open wetland habitats occur within these areas across all alternatives, and all fall within these areas under Alternative B through E. All of these areas provide emphasis and guidance on protecting habitat for TES species, and prohibit or limit many ground disturbing activities that can lead to potential habitat quality degradation. In addition, Eligible Wild Rivers and Wilderness Study Areas also provide similar protections and emphasis as these areas, although they currently are not known to harbor rare plants of open wetlands. Management direction for the remaining management areas also provides protections for TES species.

#### **Potential Management Effects**

##### **Habitat: Direct and Indirect Effects**

Open wetland habitat on the Forest is expected to remain relatively stable across all alternatives, with some losses to succession and some gains and losses from beaver activity. None of the alternatives are more likely than others to lead to a net loss or net gain of open wetland habitat. Succession of open wetlands to forested habitat would eliminate habitat for many species in this group. However, in most open wetlands, this conversion is a slow, natural process unaffected by management. In some cases, trees can be cut to maintain the open character of a wetland, but this would be done primarily to conserve habitat for TES or other desirable species. Open wetlands are also sometimes burned in order to maintain their open character and wildlife value, which has the potential to damage individual plants or populations, both directly through fire damage and indirectly through new growth of forage for herbivores that can then browse sensitive plants. Forest Plan guidance for protection of TES species should mitigate these impacts by ensuring plants are protected or kept out of the burn area, and ensuring that wetlands with sensitive plants are not targeted for creation of browse for herbivores.

In some cases, beaver or human-created dams create and maintain open wetlands. Beaver are currently active on the Forest, and are altering existing wetlands and creating new open wetlands. Dams and other human-created impoundments are governed by existing agreements on water levels and flows, and these are not likely to change over the life of the agreements. Impoundments of any kind will be maintained if

they are known to provide habitat for TES species upstream or downstream of the structure. Dam removal would be considered if an impoundment is no longer needed. Removal of beaver dams may also occur if they are damaging existing TES habitat. Revised Plan guidance related to conservation of RFSS will minimize the potential for local losses of open wetland habitat that could impact a sensitive plant species.

Across all alternatives, construction and maintenance of trails and roads for forest management and recreation management in or near wetlands can damage vegetation and change the local hydrology, making the habitat more or less suitable for some species. Forest-wide standards and guidelines for riparian area protection suggest that roads and trails should not be constructed through or adjacent to wetlands, and when they cannot be avoided, impacts are to be minimized, and hydrology and water quality are to be maintained. Because the local hydrology of some wetlands can be complicated, it is possible that hydrology can be affected even with application of standards and guidelines using the best available information, resulting in impacts to habitat and species. Trails and roads, both new and existing, can also bring people closer to these habitats, and have the potential to result in illegal off-trail use, user-created trails, and trampling of plants. Increased use and maintenance of existing trails in and near wetlands could result in increased sedimentation, pollution, and trampling, which could reduce habitat suitability for some species and affect the survival of individual plants or populations. Guidance for protection of TES species should prevent the placement of new trails or roads near known populations of sensitive plants, and should help to mitigate some of these impacts. Relocation of trails to avoid damage to TES species can also be undertaken when use levels and maintenance are a threat.

Although recreational facilities are not constructed in wetlands due to logistical challenges and standards and guidelines, the presence or construction of recreational facilities near open wetlands increases access to these habitats. This is the case for all alternatives, as levels of recreational development are not specified in the revised Plan, but are based on demand and site-specific analysis. Increased access by people can lead to both trampling of habitat and plants, as well as increased risk of infestation by NNIS like purple loosestrife. Standards and guidelines for protection of TES species will prevent new development near known populations of sensitive species. Monitoring of sensitive species required in the revised Plan will help the Forest identify circumstances where use levels are impacting sensitive plants, and adjustments in management of developed sites can be made to help mitigate these impacts. Standards and guidelines for NNIS prevention and control in all habitats should reduce the potential for indirect impacts to habitats and species.

Although open wetlands constitute less than one percent of National Forest System lands, there is some variation among alternatives related to the relative risk of these habitats encountering vegetation management and recreational uses and activities that may degrade their quality. Under Alternative A, about half of the open wetlands identified as significant are within protective designations, although revised Plan guidance requires conservation of sites identified as ecologically significant. In Alternatives B through E, all of the important wetlands identified as significant are allocated to special designations that minimize intensive management, where species of this habitat are less likely to encounter heavy recreational pressures and intensive vegetation management. Consequently, there are no substantive differences among alternatives for those sites identified as important ecologically. For all open wetlands as a group, including many that have not been inventoried, Alternative A allocates the most open wetland habitat to these special designations, about 52 percent, while Alternative B allocates the least, about 35 percent. The remaining alternatives range between allocating 40 to 43 percent of open wetland habitat to these designations. In addition, wetlands in general are not considered suitable for timber management, and so those found in other management areas during timber sale planning are generally protected and avoided. While Alternative B therefore presents the greatest risk to these wetlands of the alternatives, it is not substantially greater than the other alternatives, and Forest-wide management guidance protecting water quality, riparian areas, and TES species should alleviate this greater risk, as well as the risk to the remaining open wetlands that are not allocated to these designations under any of the alternatives.

### Populations: Direct and Indirect Effects

About half of the species in this habitat group, including *Carex aquatilis*, *Carex michauxiana*, *Cypripedium reginae*, *Eleocharis intermedia*, *Muhlenbergia uniflora*, and *Scheuchzeria palustris*, have all or most of their populations on the GMNF in protected designations across Alternatives B through E, and some in Alternative A as well. These designations include cRNA, Ecological Special Area, Remote Backcountry Forest, Wilderness, and White Rocks NRA. All of these designations emphasize protection of unique resource values, including sensitive plants and their habitats, that are associated with the designations, and in some cases are the reasons for their designation. These designations also allow management as needed to maintain habitat for sensitive species. These designations provide ecological conditions that are likely to contribute to the long-term viability of these species.

*Carex atlantica*, currently a sensitive species, is no longer considered likely to occur on the GMNF based on botanical inventories in 2003 and review of old records; previous records of this species were determined to have been misidentified (Jenkins 2003). *Blephilia hirsuta*, *Polemonium vanbruntiae* and *Torreyochloa pallida* var. *fernaldii* have at least one population within a protected designation, while *Carex schweinitzii*, *Geum laciniatum*, *Sisyrinchium angustifolium*, and *Sisyrinchium atlanticum* have none of their populations in protected designations. *Polemonium vanbruntiae*, which is a globally rare species, occurs frequently on the Forest along roadsides, and so the revised Plan provides additional protection for these occurrences, which are vulnerable to roadside mowing and road maintenance work. Forest-wide management guidance for protection of TES species, water quality, and riparian and wetland areas should mitigate potential impacts to these six species, and to populations of the other species that are not in protected areas under Alternative A.

While none of the species in this habitat group are expected to decline substantially over the next 15-20 years, several have low population numbers or additional vulnerabilities that warrant concern. Several species, like *Blephilia hirsuta*, *Carex aquatilis*, *Carex schweinitzii*, *Cypripedium reginae*, *Eleocharis intermedia*, and *Scheuchzeria palustris* require calcareous or circumneutral wetland habitat, which is rare on the Forest, so their opportunities are limited. Populations of these species are expected to remain relatively isolated on the Forest due to the isolated nature of the calcareous conditions they require, and may become genetically isolated or be lost due to a natural event such as beaver flooding or browsing by moose or deer. *Carex schweinitzii*, a globally rare species, specifically requires groundwater seepage over limestone, and may be restricted to its current site on the Forest, which is a fen within an old wet meadow that was once a home site and is now a maintained wildlife opening. This particular site may be of marginal quality due to its land use history, although it is unclear to what extent this history has degraded or improved habitat quality for the species. It is uncertain how long the species has been there or how long it will persist, as it was only discovered there recently. *Cypripedium reginae* may also be susceptible to collection and herbivory, and has a suite of life history characteristics particular to orchids that make it vulnerable to loss. These species are considered to be at moderate risk, while the other species appear to be doing well in spite of the risks they face in this habitat (SVE Open/Nonforested Wetland Plants Panel 2002; SVE Forested Wetlands Plants Panel 2002; SVE Open Rocks Plants Panel 2002). A combination of protective designations and water quality standards and guidelines, along with required monitoring and adjustments in management, will contribute to the maintenance of ecological conditions needed for long-term viability of the species in this habitat group.

### Cumulative Effects

The cumulative effects analysis area for sensitive species in this group includes all of the 12-digit subwatersheds that encompass the GMNF proclamation boundary. Using subwatersheds to define the area of analysis works best for these species because they are strongly associated with water and hydrological processes. All of the open wetland species except for *Cypripedium reginae* have fewer than 20 occurrences documented in the state. Of the species in this group that are known to occur on the GMNF, the Forest generally holds less than half of the statewide populations, except for *Blephilia hirsuta*, *Carex michauxiana*, *Muhlenbergia uniflora*, *Polemonium vanbruntiae*, *Sisyrinchium atlanticum*, and *Torreyochloa pallida* var. *fernaldii*. However, for most species in this group, the Forest does hold most of the populations within the 63 subwatersheds that encompass the GMNF proclamation boundary. *Carex schweinitzii*, *Cypripedium reginae*, and *Eleocharis intermedia* are much more abundant off-Forest than



on, as habitat on the Forest is marginal for them. The GMNF is not likely to ever become a source of populations of these species, although populations in the valleys may have the potential to repopulate the sites in which these species are currently found, if they are lost.

Wetland habitats are more abundant off-Forest than on the GMNF, particularly in the valleys and to the Northeast in Vermont. Development is also more common on lands surrounding the Forest. Historically, conversion of forest to farmland, development, and intensive timber harvest altered or eliminated many wetlands, reducing habitat, and probably populations of rare species across the Green and Taconic Mountains and adjoining valleys. Currently, some wetlands are protected from development, while impacts to others are allowed with mitigation. Due to historical impacts, remaining wetlands are more important than ever as rare communities and habitat for sensitive species. Wetlands constructed for mitigation may provide suitable habitat for some species, but they cannot replace lost populations. Surveys for rare species are not required prior to trail construction in most places off-Forest, so populations could be reduced or eliminated.

Most sensitive wetland plants are recovering from the effects of intensive habitat changes over the past decades or centuries. While some off- and on-Forest activities may impact these habitats in the next 20 years, these effects will be negligible compared to declines resulting from past drainage of wetlands and land conversions. All of the past, present, and foreseeable future impacts off the Forest make the GMNF, with its generally low levels of development, and objectives for management toward ecological tendencies, an important source of relatively undisturbed and recovering open wetland habitat for species of this group. Since Forest-wide management guidance should minimize impacts from management activities, the GMNF would continue to provide high quality habitat within the Green Mountains and GMNF subwatersheds for most species in this group.

#### **Species Determination and Rationale**

The revised Plan and its alternatives may impact individuals, but are not likely to cause a trend toward federal listing or loss of viability for any sensitive plant species associated with this habitat. Protection of known occurrences in protective designations, project mitigation measures that prevent or minimize wetland impacts, vegetation management to manage for habitat needs of TES species, and management of recreational uses within and near wetlands, should minimize negative impacts under all alternatives. However, populations of several species in this group will continue to be vulnerable to changes in hydrology caused by beaver or human activities, potential infestations of NNIS, and losses due to small single populations and very limited habitat on the Forest. Monitoring and management actions to conserve this habitat and its associated species are key factors in mitigating the effects of beaver activities, management actions, and recreational use on these populations; without them some species of this habitat are less likely to persist on the GMNF.

### **Species of Forested Wetlands**

#### **Habitat Description and Distribution**

This broad habitat category includes obvious forested wetlands, such as floodplain forests, hardwood swamps, and softwood swamps, as well as less obvious wetland habitats within conifer and hardwood forests, such as vernal pools and seeps. Forested wetlands on the GMNF are most often spruce-fir-tamarack swamp, hemlock or red spruce-hardwood swamp, or red maple-sphagnum acidic basin swamp, and occasionally red maple-black ash seepage swamp. Forested wetlands that are rare on the GMNF, occurring only once or twice, include black spruce swamp, northern white cedar swamp, red maple-black gum swamp, and calcareous red maple-tamarack swamp. Sugar maple-ostrich fern floodplain forest probably occurred along the larger rivers at the edges of the Forest, but there are no intact or functional occurrences known currently from the Forest. Areas with forested wetland habitat, or with RFSS associated with this habitat, that have been identified as ecologically significant include The Cape RNA, Dutton Brook Swamp, Bryant Mountain Hollow, Leicester Hollow, Mt. Tabor Work Center Swamp, Little Rock Pond, Mt. Horrid, Stratton Mountain, Abbey Pond, Grout Pond, Lost Pond Bog, Lottery Road Swamp, West River Headwater Cove, Colebrook Trail Swamp, vernal pools along the AT Corridor east of the GMNF, and vernal pools located along the escarpment.

Forested wetlands, and wetlands in general, are concentrated within the low hill, low slope, plateau, and valley landscapes of the Forest. These landscapes are more prominent in the southern portion of the Forest, although they are also common in the Middlebury District. National Wetland Inventory maps show over 3,400 acres of forested wetlands scattered across the GMNF, in more than 1,000 patches averaging 3 acres in size, and ranging from less than an acre to about 50 acres. About 15 percent of forested wetlands on the Forest are classified as dead, likely due to flooding by beaver activity. While forested wetlands tend to be associated with particular landscapes across the Forest, seep and vernal pool habitats are much more widely distributed, being most common in ecological types that have shallow hardpan or shallow to bedrock soils. They are also generally not mapped as part of National Wetland Inventory maps because they are hard to detect from the air; consequently their distribution is not well understood. Rich northern hardwood and lowland spruce-fir forests are particularly likely to include seep and vernal pool habitat, although these small wetland habitats are also found embedded within the full spectrum of hardwood and conifer forest communities.

The forested wetland habitat group provides for a wide variety of wetland habitat conditions. Within this group, species often have specific habitat requirements primarily associated with water quality, water chemistry, climate, elevation, physiography, light levels, previous land use, and beaver activity. Higher moisture levels are what separate these habitats from general forest habitats. Shading and tree density are variable, although these areas are generally considered partially to fully shaded. Most forested wetlands on the Forest are acidic, but the rare occurrences of calcium-enriched wetlands harbor all of the rare plants of this group. Jenkins (1981) suggests that many rare plants associated with wetlands require wetlands that are stable and have developed over long periods of time. Some forested wetland species can exploit atypical wetlands created by historic and current land management patterns, such as roadside ditches, log landings, and woods roads that are partially shaded and wet.

Table 5-9 shows the 10 RFSS plants that are sensitive on the GMNF with affinities for forested wetland habitat, including their specific habitat requirements, biological factors that may be important to viability, and numbers on the GMNF. This information is based on literature reviews and discussions with botanists regarding these species, and is documented in species summaries (USDA 2004) and the project file.

<b>Table 5-9: RFSS Plants of Forested Wetland Habitats and factors affecting their viability</b>			
<b>Species</b>	<b>Habitat Requirements</b>	<b>Biological Factors</b>	<b>Occurrences (extant or historical)</b>
<i>Blephilia hirsuta</i>	Calcium- and nutrient-enriched woodland seeps and wet edges of enriched northern hardwoods, swamp forests, floodplains, and wet meadows, generally below 2,500' elevation	Insect pollinated; vegetative reproduction; edge of range	4 extant and 4 historical in VT; 3 extant and 1 historical in cumulative effects analysis area; 3 extant on GMNF
<i>Carex schweinitzii</i>	Open and forested wetlands where groundwater seeps over limestone bedrock, including cedar swamps, red maple-tamarack swamps, and edges of fens and wet meadows	Globally rare; strong vegetative reproduction; forms extensive colonies	15 extant and 4 historical in VT; 11 extant and 4 historical in cumulative effects analysis area; 1 extant on GMNF
<i>Cypripedium parviflorum</i> var. <i>pubescens</i>	Calcium-enriched or nutrient enriched wet-mesic soils and seeps of rich northern hardwood forests and swamps; generally below 1,500'; generally prefers light shade and partial sun	Vigorous vegetative reproduction; pollinated by bees; low seed viability; 12 years to flowering; long-lived; dependent on soil mycorrhizae;	Uncertain #'s in VT and cumulative effects analysis area due to recent taxonomic changes; 5 extant on GMNF

Table 5-9: RFSS Plants of Forested Wetland Habitats and factors affecting their viability			
Species	Habitat Requirements	Biological Factors	Occurrences (extant or historical)
<i>Cypripedium reginae</i>	Restricted to calcareous wetlands, including fens, cedar swamps, red maple-tamarack swamps, shrubby edges of wooded swamps; generally below 1,500'	Pollinated by insects; low flowering and low seed viability; vegetative reproduction; 15 years to flower; dependent on soil mycorrhizae	69 extant and 18 historical in VT; 16 extant and 17 historical in cumulative effects analysis area; 3 extant on GMNF
<i>Galium kamtschaticum</i>	Calcium or nutrient-enriched seeps in wet woods, swamps, and streamsides, in shallow mucky soils, in closed or partially open hardwood, softwood, or mixed forests, generally above 1,800' elevation; prefers non-channelized flowing surface water	Possible animal dispersal of seeds; nationally rare	1 extant and 10 historical in VT; 4 historical in cumulative effects analysis area; 1-4 historical records on GMNF
<i>Juglans cinerea</i>	Moist, calcium or nutrient-enriched, sometimes rocky soils of rich northern hardwood, oak-northern hardwood, and floodplain forests, generally below 2,500'	Primary threat is butternut canker; requires light for germination	Known to occur in all counties in VT; at least 10 areas with several butternut trees in each known from GMNF
<i>Platanthera orbiculata</i>	Calcium or nutrient enriched northern hardwood and oak forests at low elevations, or moist boreal conifer woods or swampy woods at moderate elevations	Moth pollination; infrequent flowering; dependent on soil mycorrhizae; browsed heavily by deer and slugs; collectors; long-lived	At least 30 records for VT; uncertain # of records from cumulative effects analysis area; 4 extant and 4 historical on GMNF
<i>Polemonium vanbruntiae</i>	Wet, seepy, circumneutral soils of open to partially open wetlands, shores, wet woods, and ditches, generally below 2,000'	Vigorous vegetative reproduction; restricted to one county in VT; isolated from closest populations in NY and ME	9 extant in VT; 8 extant in cumulative effects analysis area; 7 extant on GMNF
<i>Pyrola chlorantha</i>	Dry, calcium-enriched deciduous or coniferous forests at moderate elevations, or alkaline softwood swamps at lower elevations, in deep humus, moss, or conifer litter	Bee pollination; mycorrhizal relationship	At least 13 records for VT; at least 6 records from the cumulative effects analysis area; 1 historical on GMNF
<i>Ribes triste</i>	Mostly calcium-enriched, seepy or swampy, deciduous or coniferous woods, or subalpine conifer forests; partial sun to full shade.	Vegetative reproduction; seeds may be animal dispersed; historical eradication due to hosting white pine blister rust	At least 22 records in VT, of which at least 12 are extant; 13 records in cumulative effects analysis area; 10 extant and 3 historical on GMNF

### **Limiting Factors and Threats**

Primary limiting factors associated with this habitat include its distribution and quality. While forested wetlands in general are well distributed across the Forest, with a higher concentration in the southern portion of the Forest, calcium-enriched wetlands are rare, known from small isolated areas on both the northern and southern portions of the Forest. Calcareous wetlands tend to be restricted to areas of calcareous bedrock or till, which are more common in the Champlain and Vermont Valleys, and restricted

to the escarpment and small narrow bands widely scattered across the Forest. Peatlands are also very rare on the Forest, particularly forested bogs. Seeps and vernal pools associated with more acidic conditions appear to be well distributed across the Forest, although there has been no comprehensive inventory or study of these habitats to determine what governs their distribution.

Habitat quality tends to be limited by the amount of disturbance affecting the wetland. Some species are associated with disturbed, partially shaded conditions, including wetland edges, tree falls, and tip-up mounds, while others prefer a closed canopy. Several species specifically prefer a stable source of groundwater seepage over calcium or mineral-enriched bedrock or till. Some species also have specific preferences for deep humus layers.

Development and changes to hydrology can negatively impact all forested wetlands. Development can eliminate wetland habitat and alter water quality and quantity. Roads, trails, dams, and other management in or near forested wetlands can change the local hydrology, making habitat more or less suitable for some species. Logging can also alter local hydrology, as well as humus development, shading, and temperature of mature forest wetlands, making them unsuitable for some species. However, development of deep shade in wetlands can also reduce habitat suitability for other species. NNIS can invade forested wetlands that have been disturbed and out-compete native species, including rare plants, as well as change ecosystem processes in wetlands. Beaver activity can also alter local hydrology by flooding forested wetlands, killing trees and eliminating habitat for rare plants of forested wetlands, converting forested wetlands to open wetlands. Activities permitted under the revised Forest Plan that can affect forested wetland habitats include vegetation management, and construction, maintenance, and use of trails and roads.

#### **Management Direction Pertinent to Forested Wetland Habitat**

Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to sensitive plants within these habitats. There is no species-specific management direction in the revised Forest Plan for most of the sensitive plants of this habitat group. Specific guidance for *Polemonium vanbruntiae* includes protection measures for roadside populations. Forested wetland habitats are protected by water quality and riparian area guidance found in the revised Plan. Resource protection measures include minimizing ground-disturbance and tree removal within protective buffers adjacent to wetland habitats; avoiding wetlands during stream crossings; restricting use of heavy equipment and other activities to minimize erosion and sedimentation; ensuring that servicing and refueling of equipment happens outside protective buffers; restricting use of wetlands for roads and trails; and restricting vegetation management within wetlands.

Management direction within RNA/cRNAs, Ecological Special Areas, Wilderness, and White Rocks NRA are applicable to these habitats because a majority of the identified important wetland habitats or sites for RFSS in this group occur within these areas across all alternatives. All of these areas provide emphasis and guidance on protecting habitat for TES species, and prohibit or limit many ground disturbing activities that can lead to potential habitat quality degradation. Most of these areas also allow management to maintain habitat for TES species. In addition, Eligible Wild Rivers, Remote Backcountry Forest, and Wilderness Study Areas also provide similar protections and emphasis as these areas, although they currently are not known to harbor rare plants of forested wetlands. Management direction for the remaining management areas also provides protections for TES species.

#### **Potential Management Effects**

##### **Habitat: Direct and Indirect Effects**

Forested wetland habitat on the Forest is expected to remain relatively stable over the next 20 years and the long-term across all alternatives, with some gains as some open wetlands succeed to forest, and some losses from beaver activity. None of the alternatives are more likely than others to lead to a net loss or net gain of forested wetland habitat. Revised Plan objectives are to manage toward ecological tendencies, which would generally allow natural processes of succession and beaver activities in these habitats unless those activities are threatening TES species or other resource values. The amount of calcareous forested wetland habitat is not expected to change across alternatives, as its distribution and

quantity are governed by calcareous substrates on the Forest, which are rare. It is unlikely that much more of this habitat will be found on the Forest, and so this habitat and its associated species are most likely restricted to currently known sites.

Succession of open wetlands to forested habitat may improve habitat for many species in this group by providing more shade and humus development, and stabilizing hydrology. However, in most wetlands, this conversion is a slow, natural process, taking decades or centuries. Beaver, on the other hand, are currently active on the Forest, and are altering existing wetlands. At least 15 percent of the forested wetlands identified on the GMNF as part of the National Wetlands Inventory are identified as dead, likely through flooding by beaver. This suggests that beaver can have impacts on this habitat by converting forested wetlands to open wetlands and ponds. Forest Plan guidance for protection of TES species would help to mitigate these impacts by allowing removal of beaver dams or installation of structures that minimize the impacts beaver flooding may have on a wetland. However, given the number of wetlands on the Forest, beaver can alter or destroy habitat before these impacts are detected, and so this activity has the potential to result in loss of habitat and decline in populations of sensitive species associated with it. The beneficial impacts of natural succession, and the negative impacts of beaver flooding, are consistent across all alternatives.

In some cases, succession to forested wetlands is deliberately interrupted through removing trees or burning. These activities are usually undertaken either to conserve habitat for TES or other desirable species. These activities have the potential to limit opportunities for development of forested wetland habitat in the future, and so can limit opportunities for populations of sensitive species to expand. In addition, wetlands that are partially wooded provide habitat for some species in this group, and cutting trees or burning can damage individual plants or populations and degrade or eliminate habitat. These activities can also attract herbivores that browse on species like orchids, of which three are part of this habitat group. However, maintaining a partially open canopy can be beneficial for some species that do not do well in deep shade. Forest Plan guidance for protection of TES species should mitigate these impacts by ensuring plants are protected or kept out of burn areas, and ensuring that forested or partially wooded wetlands with sensitive plants are not targeted for conversion to openings and creation of browse for herbivores.

Forested wetlands such as forested bogs and swamps, generally stay wet enough during the year that they are logistically difficult to log, and often are not considered productive or valuable for timber. On the other hand, seeps, vernal pools, and floodplain forests are particularly vulnerable to vegetation management in terms of changes to shading, temperature, and hydrology, regardless of alternative. The general forest environment in which these wetlands are found can accommodate timber harvesting during certain times of year when soils have become dry or frozen. These forested wetlands often include or are surrounded by productive forestlands that provide tree species valued for wood products. Seeps and vernal pools can also be difficult to locate during inventories of stands, and so can be overlooked. Consequently, timber harvesting may affect these habitats, resulting in reduction in shade, increases in temperature, and changes to hydrology, all of which can lead to declines in sensitive species that may be associated with a particular harvested site. Standards and guidelines for riparian buffers and protection of wetlands would reduce adverse impacts to forested wetland habitat by limiting the level of ground disturbance and canopy loss in and around forested wetlands, including seeps, vernal pools, and floodplain forests. Guidance for protection of TES species would mitigate impacts to habitat where sensitive plants are located.

Across all alternatives, construction and maintenance of trails and roads for forest management and recreation management in or near wetlands can damage vegetation and change the local hydrology, making the habitat more or less suitable for some species. Forest-wide standards and guidelines for riparian area protection suggest that roads and trails should not be constructed through or adjacent to wetlands, and when they cannot be avoided, impacts are to be minimized, and hydrology and water quality are to be maintained. Because the local hydrology of some wetlands can be complicated, it is possible that hydrology can be affected even with application of standards and guidelines using the best available information, resulting in impacts to habitat and species. Trails and roads, both new and

existing, can also bring people into these habitats, and have the potential to result in illegal off-trail use, user-created trails, and trampling of plants. Increased use and maintenance of existing trails in and near wetlands could result in increased sedimentation, pollution, and trampling, which could reduce habitat suitability for some species and affect the survival of individual plants or populations. Guidance for protection of TES species should prevent the placement of new trails or roads near known populations of sensitive plants, and should help to mitigate some of these impacts. Relocation of trails to avoid damage to TES species can also be undertaken when use levels and maintenance are a threat.

Although recreational facilities are not constructed in wetlands due to logistical challenges and standards and guidelines, the presence or construction of recreational facilities near wetlands increases access to these habitats. This is the case for all alternatives, as levels of recreational development are not specified in the revised Plan, but are based on demand and site-specific analysis. Increased access by people can lead to both trampling of habitat and plants, as well as increased risk of infestation by NNIS like garlic mustard or goutweed. Standards and guidelines for protection of TES species will prevent new development near known populations of sensitive species. Monitoring of sensitive species required in the revised Plan will help the Forest identify circumstances where use levels are impacting sensitive plants, and adjustments in management of developed sites can be made to help mitigate these impacts. Standards and guidelines for NNIS prevention and control in all habitats should reduce the potential for indirect impacts to habitats and species.

Although forested wetlands constitute less than one percent of National Forest System lands, there is some variation among alternatives related to the relative risk of these habitats encountering vegetation management and recreational uses and activities that may degrade their quality. In Alternatives B through E, most of the important wetlands identified as significant are allocated to special designations that minimize intensive management, where species of this habitat are less likely to encounter heavy recreational pressures and intensive vegetation management. Under Alternative A, only about five of these areas are within protective designations, although revised Plan guidance requires conservation of sites identified as ecologically significant. Consequently, there are no differences among alternatives for those sites identified as important ecologically. For forested wetlands as a group, including many that have not been inventoried, Alternative A allocates the most forested wetland habitat to these special designations, about 54 percent, while Alternative B allocates the least, about 37 percent. The remaining alternatives range between allocating 43 to 46 percent of forested wetland habitat to these designations. While Alternative B therefore presents the greatest risk to these wetlands of the alternatives, it is not substantially greater than the other alternatives, and Forest-wide management guidance protecting water quality, riparian areas, and TES species should alleviate this greater risk, as well as the risk to the remaining significant forested wetlands that are not allocated to these designations under any of the alternatives.

#### Populations: Direct and Indirect Effects

About a third of the species in this habitat group, including *Cypripedium reginae*, *Galium kamschaticum*, and *Pyrola chlorantha*, have all or most of their occurrences on the GMNF in special designations across Alternatives B through E, and some in Alternative A as well. For *Galium kamschaticum* and *Pyrola chlorantha*, these occurrences are historical records, as neither is presently known on the Forest. These special designations include RNA/cRNA, Ecological Special Area, and White Rocks NRA. All of these designations emphasize protection of unique resource values, including sensitive plants and their habitats, that are associated with the designations, and in some cases are the reasons for their designation. These designations also allow management as needed to maintain habitat for sensitive species. These designations provide ecological conditions that are likely to contribute to the long-term viability of these species.

*Juglans cinerea* is declining dramatically due to a disease that is beyond the control of the Forest to manage, beyond maintaining existing individuals and populations that show signs of resistance. Revised Plan guidance encourages cooperation with other agencies in halting the decline in this species, including establishment of seed orchards or small plantations to help test butternut resistance. The alternatives do not vary in regard to management for this species.

*Blephilia hirsuta*, *Cypripedium parviflorum* var. *pubescens*, *Platanthera orbiculata*, *Polemonium vanbruntiae* and *Ribes triste* have at least one population within a protected designation, while *Carex schweinitzii* has no populations within special designations. *Polemonium vanbruntiae*, which is a globally rare species, occurs frequently on the Forest along roadsides, and so the revised Plan provides additional protection for these occurrences, which are vulnerable to roadside mowing and road maintenance work. Forest-wide management guidance for protection of TES species, water quality, and riparian and wetland areas should mitigate potential impacts to these six species, and to populations of the other species that are not in protected areas under any of the alternatives.

All species in this group require calcareous or circumneutral habitat on the Forest, which is generally rare on the Forest. However, *Polemonium vanbruntiae* has also adapted to occur in some atypical habitats, such as roadsides, and has been observed to respond positively to some timber harvesting activities, suggesting it is somewhat resilient and less vulnerable on the GMNF. *Galium kamschaticum* and *Ribes triste* are both considered somewhat overlooked, and more populations are likely to be found with additional inventories (SVE Upland Forest Plants Panel 2002). Because *Polemonium vanbruntiae* is globally rare, and *Galium kamschaticum* is rare nationally, both are considered vulnerable to loss across their ranges in the United States, and are protected by Forest Service policy, even when populations are doing well on the Forest. However, all three species are considered to be doing fairly well on the Forest (SVE Upland Forest Plants Panel 2002; SVE Forested Wetland Plants Panel 2002) within the context of current designations and protective standards and guidelines, which are expected to improve with Alternatives B through E.

While none of the species in this habitat group except *Juglans cinerea* are expected to decline substantially over the next 15-20 years, several have low population numbers or additional vulnerabilities that warrant concern. Species with low numbers, like *Blephilia hirsuta*, *Carex schweinitzii*, *Cypripedium reginae*, and *Pyrola chlorantha*, are fairly isolated and expected to remain relatively isolated on the Forest due to the isolated nature of the calcareous conditions they require. These species may become genetically isolated or be lost due to a natural event such as beaver flooding or browsing by moose or deer. *Carex schweinitzii*, a globally rare species, specifically requires groundwater seepage over limestone, and may be restricted to its current site on the Forest, which is a fen within an old wet meadow that was once a home site and is now a maintained wildlife opening. This particular site may be of marginal quality due to its land use history, although it is unclear to what extent this history has degraded or improved habitat quality for the species. It is uncertain how long the species has been there or how long it will persist, as it was only discovered there recently. *Cypripedium reginae*, *Cypripedium parviflorum* var. *pubescens*, and *Platanthera orbiculata* may also be susceptible to collection and herbivory, and they have a suite of life history characteristics particular to orchids that make them vulnerable to loss. *Pyrola chlorantha* is only known historically from the Forest at one site, and although its presence has not been recently confirmed, it has not been located elsewhere on the Forest. These species are considered to be at moderate risk, while the other species appear to be doing well in spite of the risks they face in this habitat (SVE Forested Wetlands Plants Panel 2002; SVE Upland Forest Plants Panel 2002). A combination of protective designations and water quality standards and guidelines, along with required monitoring and adjustments in management, will contribute to the maintenance of ecological conditions needed for long-term viability of the species in this habitat group.

#### Cumulative Effects

The cumulative effects analysis area for sensitive species in this group includes all of the 12-digit subwatersheds that encompass the GMNF proclamation boundary. Using subwatersheds to define the area of analysis works best for these species because they are strongly associated with water and hydrological processes. Several forested wetland species have fewer than 20 occurrences documented across Vermont, including *Blephilia hirsuta*, *Carex schweinitzii*, *Galium kamschaticum*, *Polemonium vanbruntiae*, and *Pyrola chlorantha*. Vermont does not track populations of *Juglans cinerea*, and so current numbers or proportions on the GMNF are not known. The taxonomy of the yellow ladyslippers has changed over the last decade, and Vermont has not reevaluated its population numbers for *Cypripedium parviflorum* var. *pubescens*. However, for both of these species, it is likely that populations are more abundant off the Forest than on, due to the greater quantity of wetlands and calcareous soils off

the Forest. Of the species in the group that are known to occur on the GMNF, only *Polemonium vanbruntiae*, *Blephilia hirsuta*, and *Ribes triste* have a greater proportion of their populations on the Forest than off the Forest, again, likely due to the relative proportion of calcareous habitat. Aside from these species, the GMNF is not likely to ever become a source of populations for these species, although populations off the Forest may have the potential to repopulate the sites in which these species are currently found if they are lost. Populations of *Juglans cinerea* may provide sources of resistant genotypes due to their comparative isolation from the bulk of the populations in Vermont, although most butternut trees sampled on the GMNF are infected.

Wetland habitats are more abundant off-Forest than on the GMNF, particularly in the valleys and to the Northeast in Vermont. Development is also more common on lands surrounding the Forest. Historically, conversion of forest to farmland, development, and intensive timber harvest altered or eliminated many wetlands, reducing habitat, and probably populations of rare species across the Green and Taconic Mountains and adjoining valleys. Currently, some wetlands are protected from development, while impacts to others are allowed with mitigation. Due to historical impacts, remaining wetlands are more important than ever as rare communities and habitat for sensitive species. Wetlands constructed for mitigation may provide suitable habitat for some species, but they cannot replace lost populations. Surveys for rare species are not required prior to timber harvesting or trail construction in most places off-Forest, so populations could be reduced or eliminated.

Most sensitive wetland plants are recovering from the effects of intensive habitat changes over the past decades or centuries. While some off- and on-Forest activities may impact these habitats in the next 20 years, these effects will be negligible compared to declines resulting from past drainage of wetlands and land conversions. All of the past, present, and foreseeable future impacts off the Forest make the GMNF, with its generally low levels of development, and objectives for management toward ecological tendencies, an important source of relatively undisturbed and recovering forested wetland habitat for species of this group. Since Forest-wide management guidance should minimize impacts from management activities, the GMNF would continue to provide high quality habitat within the Green Mountains and GMNF subwatersheds for most species in this group.

#### **Species Determination and Rationale**

The revised Plan and its alternatives may impact individuals, but are not likely to cause a trend toward federal listing or loss of viability for any sensitive plant species associated with this habitat. Protection of known occurrences in protective designations, project mitigation measures that prevent or minimize wetland impacts, vegetation management to manage for habitat needs of TES species, and management of recreational uses within and near wetlands, should minimize negative impacts under all alternatives. However, populations of several species in this group will continue to be vulnerable to changes in hydrology caused by beaver or human activities, potential infestations of NNIS, and losses due to small single populations and very limited habitat on the Forest. Monitoring and management actions to conserve this habitat and its associated species are key factors in mitigating the effects of beaver activities, management actions, and recreational use on these populations; without them some species of this habitat are less likely to persist on the GMNF.

### **Species of Rich Northern Hardwood Forest**

#### **Habitat Description and Distribution**

Rich northern hardwood forest habitat is a forested natural community dominated by sugar maple; white ash is also common, while basswood and butternut are occasional (Thompson and Sorenson 2000). Beech and yellow birch are less abundant than they would be in a typical stand of northern hardwoods. On occasion, hemlock, red spruce, and red oak occur in these stands as well. Transition limestone hardwood forest may be considered part of this group, as it represents the enriched mesic conditions of the community at lower elevations and warmer climates (Thompson and Sorenson 2000). Areas with rich northern hardwood habitat, or with RFSS associated with this habitat, that have been identified as ecologically significant include Grout Pond, Downer Glen, parts of Big Branch Wilderness, McGinn Brook, Peabody Hill, Thistle Hill, Handy Road Woods, The Cape RNA, Mount Horrid, Leicester Hollow, Chandler



Ridge, Bryant Mountain Hollow, Dutton Brook Swamp, Elephant Mountain, Bristol Cliffs, and Beaver Meadows/Abbey Pond.

Rich northern hardwood forests are fairly uncommon on the GMNF, but tend to be more common in the mountains of Vermont than in New Hampshire or Maine. The smallest and most isolated patches occur in the Green Mountains at moderate elevations; the largest patches occur in the Taconic Mountains, where the community tends to reach its most characteristic development. Often, the community is associated with calcareous substrates, including limestone, marble, dolomite, calcareous schist, and calcareous till. Bedrock maps of Vermont indicate calcareous rocks are restricted to small, narrow, widely scattered bands in the Green Mountains, although it is more common along the escarpment on the western edge of the Forest, as well as in the Vermont and Champlain Valleys and the Taconic Mountains. Calcareous rock types expected to provide potential rich northern hardwood habitat based on Ecological Land Unit Group (ELUG) mapping (Burbank 2004) account for about 4,600 acres on the Forest, or about one percent of National Forest System lands. Patches of this habitat generally range from less than an acre to about 212 acres, and average four acres in size.

Although calcareous rock and related rich northern hardwoods can be predicted, other forms of this habitat cannot. Till chemistry has not been mapped for Vermont, although calcareous till is known to occur in certain local areas on the GMNF. Soil and ecological landtype (ELT) maps do not recognize a calcareous soil type in the mountains, although local examples of such types exist on the ground. This community can also form in places in the landscape that are moist and tend to pool organic matter (referred to as a composting effect). Landforms such as toe slopes, coves, and colluvial slopes can provide rich northern hardwood forest habitat in places that are mesic and are at elevations dominated by northern hardwoods, although many of these places do not offer suitable habitat. Some of the rare species in this habitat are often found at the base of trees, indicating a possible connection to nutrients in the water flowing down the tree stems. Consequently, rich northern hardwood forests appear to have a limited, and somewhat unpredictable, distribution in the GMNF, probably less than 2 percent of NFS lands.

Ecologists consider rich northern hardwoods among the most diverse forests in Vermont. Productivity, both in terms of wood and overall biomass, also tends to be high in these communities. These sites tend to be fertile, either from nutrients, minerals like calcium, or both. They are generally moist, sometimes seepy, with a thick A soil horizon and litter. A relatively closed canopy with small gaps allows light to the forest floor without impacting the mesic soil conditions. The herbaceous layer tends to be lush, and usually includes species that are indicative of rich hardwood conditions, such as blue cohosh and maidenhair fern. Many spring ephemeral species are found in the understories of these habitats.

Table 5-10 shows the 12 RFSS plants that are sensitive on the GMNF with affinities for rich northern hardwood forests, including their specific habitat requirements, biological factors that may be important to viability, and numbers on the GMNF. This information is based on literature reviews and discussions with botanists regarding these species, and is documented in species summaries (USDA 2004) and the project file.

<b>Table 5-10: RFSS Plants of Enriched Northern Hardwood Forest Habitats and factors affecting their viability</b>			
<b>Species</b>	<b>Habitat Requirements</b>	<b>Biological Factors</b>	<b>Occurrences (extant or historical)</b>
<i>Blephilia hirsuta</i>	Calcium- and nutrient-enriched woodland seeps and wet edges of enriched northern hardwoods, swamp forests, floodplains, and wet meadows, generally below 2,500' elevation	Insect pollinated; vegetative reproduction; edge of range	4 extant and 4 historical in VT and cumulative effects analysis area; 3 extant on GMNF

<b>Table 5-10: RFSS Plants of Enriched Northern Hardwood Forest Habitats and factors affecting their viability</b>			
<b>Species</b>	<b>Habitat Requirements</b>	<b>Biological Factors</b>	<b>Occurrences (extant or historical)</b>
<i>Carex aestivalis</i>	Calcium or nutrient-enriched rocky forests, usually of oak-northern hardwoods or rich northern hardwoods, generally on mesic soils and steep slopes, generally below 2,500', in fairly open understories or associated with gaps		9 extant and 1 historical in VT and cumulative effects analysis area; 4 extant on GMNF
<i>Collinsonia canadensis</i>	Rich hardwood, oak-hardwood, and floodplain forests on moist, calcareous substrates, generally below 1,000'; sometimes associated with edges	Northeastern edge of range; genetic isolation	6 extant and 7 historical in VT and cumulative effects analysis area; 1 extant on GMNF
<i>Cypripedium parviflorum</i> var. <i>pubescens</i>	Calcium-enriched or nutrient enriched wet-mesic soils and seeps of rich northern hardwood forests and swamps; generally below 1,500'; generally prefers light shade and partial sun	Vigorous vegetative reproduction; pollinated by bees; low seed viability; 12 years to flowering; long-lived; dependent on soil mycorrhizae;	Uncertain #'s in VT and cumulative effects analysis area due to recent taxonomic changes; 5 extant on GMNF
<i>Dryopteris filix-mas</i>	Calcium-enriched, cool, mesic northern hardwood and mixed forests, often in coves and ravines, generally between 1,300' - 2,300'	Restricted to central VT from Brandon to Woodstock; limited spore dispersal; requires light for germination; long-lived; mycorrhizal relationship; hybridization with <i>D. marginalis</i> ; deer herbivory	12 extant and 10 historical in VT; 12 extant and 9 historical in cumulative effects analysis area; 2 extant on GMNF
<i>Eupatorium purpureum</i>	Moist, calcium-enriched soils of rich northern hardwoods and various mixed oak-hardwood forest types, generally below 1,000', generally in partial or full shade	Genetic isolation; deer herbivory	12 extant and 7 historical in VT; 12 extant and 5 historical in cumulative effects analysis area; 1 extant on GMNF
<i>Juglans cinerea</i>	Moist, calcium or nutrient-enriched, sometimes rocky soils of rich northern hardwood, oak-northern hardwood, and floodplain forests, generally below 2,500'	Primary threat is butternut canker; requires light for germination	Known to occur in all counties in VT; at least 10 areas with several butternut trees in each known from GMNF
<i>Panax quinquefolius</i>	Calcium and nutrient-enriched, cool, moist soils of rich northern hardwood and mixed forests with deep organic soil layers and full shade	Primary threat is harvesting of roots; slow-growing and long-lived; 3-4 years before reproduction	50 extant and 19 historical in VT; 42 extant and 15 historical in cumulative effects analysis area; 10 extant on GMNF
<i>Phegopteris hexagonoptera</i>	Calcium or nutrient enriched, warm, moist, light soils of rich northern hardwood and oak-northern hardwood forests, generally below 1,500', under a high canopy	Slow vegetative reproduction	14 extant and 12 historical in VT and cumulative effects analysis area; 3 extant and 1 historical on GMNF

<b>Table 5-10: RFSS Plants of Enriched Northern Hardwood Forest Habitats and factors affecting their viability</b>			
<b>Species</b>	<b>Habitat Requirements</b>	<b>Biological Factors</b>	<b>Occurrences (extant or historical)</b>
<i>Platanthera orbiculata</i>	Calcium or nutrient enriched northern hardwood and oak forests at low elevations, or moist boreal conifer woods or swampy woods at moderate elevations	Moth pollination; infrequent flowering; dependent on soil mycorrhizae; browsed heavily by deer and slugs; collectors; long-lived	At least 30 records for VT; uncertain # of records from cumulative effects analysis area; 4 extant and 4 historical on GMNF
<i>Ribes triste</i>	Mostly calcium-enriched, seepy or swampy, deciduous or coniferous woods, or subalpine conifer forests; partial sun to full shade.	Vegetative reproduction; seeds may be animal dispersed; historical eradication due to hosting white pine blister rust	At least 22 records in VT, of which at least 12 are extant; 17 records in cumulative effects analysis area; 10 extant and 3 historical on GMNF
<i>Uvularia perfoliata</i>	Circumneutral, generally calcium-enriched, mesic soils of rich northern hardwood, oak-northern hardwood, and mixed forests on southern aspects, generally below 1,000', generally in dappled shade	Colonial plant with vegetative reproduction; insect pollination; low seed output; 2-year seed dormancy before germination	6 extant and 4 historical in VT and cumulative effects analysis area; 1 extant on GMNF

### **Limiting Factors and Threats**

The primary limiting factors for this habitat are its distribution, and the quality of the occurrences of this habitat. The low proportion of nutrient or mineral-rich soils in the Green Mountains limits the occurrence of this habitat on the GMNF. Aside from small local areas scattered across the Forest, the bulk of these forests are found at the base of the escarpment on the western edge of the Forest, and then in the Vermont Valley and the lower to middle elevations of the Taconics.

The quality of rich northern hardwood habitat for various associated species is controlled both by the combinations of physical factors associated with the habitat, and threats to the habitat that have had impacts in the past and may continue to have impacts. Many species have microhabitat preferences, such as certain combinations of landscape position, levels of calcium, and moisture levels, which restrict their distribution to a small subset of these habitats. For most species, these preferences are not well understood, although they are apparent because most are not found in every occurrence of the habitat.

Development and agriculture, timber harvest, trail and road management, invasive species, herbivory, and genetic isolation are the primary threats that impact this habitat and the rare species that use it. Development and agriculture have resulted in the loss of habitat patches in Vermont, particularly in the Vermont and Champlain Valleys, and in the lower elevations of the Taconics. On agricultural sites that have been abandoned and are returning to forest, there is evidence that the native flora may take a long time to return (Thompson and Sorenson 2000). Timber harvest and vegetation management can alter the moisture, light, and temperature regimes of a site, improve conditions for NNIS, and directly impact rare plants. Several RFSS occur adjacent to trail corridors, and so changes in the recreational use of a trail (such as conversion from hiking only to hiking and motorized use), as well as trail maintenance and reconstruction, can directly impact these species leading to loss of populations. These habitats are often seepy, and so similar concerns noted earlier for forested wetlands also apply here, particularly impacts to hydrology from road and trail management. NNIS can out-compete rare species associated with this habitat. Deer and turkey directly impact plants by browsing them, and herbivory by these animals can be encouraged through timber harvesting that creates browse near or in this habitat. Potential species-specific threats include collection of ginseng and orchids to their exclusion from sites, as well as disease

that is killing butternut. The isolated nature of this habitat in the Green Mountains can also lead to genetic isolation of some populations of RFSS.

### **Management Direction Pertinent to Rich Northern Hardwood Forest Habitat**

Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to sensitive plants within these habitats. There is no species-specific management direction in the revised Forest Plan for most of the sensitive plants of this habitat group. Forested wetland habitats that may be embedded within rich northern hardwoods are protected by water quality and riparian area guidance found in the revised Plan and noted in the previous two wetland habitat discussions. Because these habitats tend to be highly productive, they are highly valued for timber as well as for biodiversity. Consequently, timber and vegetation management standards and guidelines would also apply to these areas. While this guidance indicates under what circumstances different silvicultural techniques would be used, and how they would be implemented, there is no specific silvicultural guidance for this habitat.

Management direction within RNA/cRNAs, Ecological Special Areas, and Wilderness are applicable to these habitats because a majority of the identified important rich northern hardwood habitats or sites for RFSS in this group occur within these areas across all alternatives. Some areas that are shown on bedrock maps as providing calcareous rock substrates are also included in these management areas, although their extent in these areas varies by alternative. All of these management area designations provide emphasis and guidance on protecting habitat for TES species, and prohibit or limit many ground disturbing activities that can lead to potential habitat quality degradation. Most of these areas also allow management to maintain habitat for TES species. In addition, Eligible Wild Rivers, Remote Backcountry Forest, and Wilderness Study Areas also provide similar protections and emphasis as these areas, although they currently are not known to harbor rare plants of rich northern hardwood habitat. Management direction for the remaining management areas also provides protections for TES species.

### **Potential Management Effects**

#### **Habitat: Direct and Indirect Effects**

Alternatives are not expected to differ in terms of the amount of rich northern hardwood habitat that is impacted by various management activities. The distribution of this habitat tends to be isolated and in small patches across the Green Mountains, and the likelihood that any particular patch is identified for a management activity is quite small. While the habitat is more widespread in the Vermont Valley and the Taconics, there is very little federal ownership of this habitat in those areas. None of the alternatives identify activities that specifically require or target these habitats. Half of the areas identified above as significant ecological examples of this habitat are allocated to special designations under Alternative A, and three-quarters are so allocated under Alternatives B through E. Within these designations, including RNAs/cRNAs, Ecological Special Areas, Remote Backcountry Forest, Wilderness, Wilderness Study Area, White Rocks NRA, and Newly Acquired Lands, management activities are geared toward supporting the ecological or natural values associated with these areas, and they are most likely to provide high quality habitat for sensitive species of this habitat. Revised Plan guidance also calls for conservation of significant natural communities, so the remaining areas not in special designations would be protected as well.

The alternatives do vary in regard to the relative risks to rich northern hardwood habitat from the different management area allocations and associated types of management activities that may occur within them. While there is no way to predict how all occurrences of rich northern hardwood forest on the GMNF are allocated across alternatives, as there is currently no model that accurately maps these occurrences, calcareous bedrock likely to harbor rich northern hardwoods is mapped and can be evaluated by alternative. While none of the alternatives allocate more than about 1,737 acres of this calcareous rock-based rich northern hardwoods to special designations or lands unsuitable for timber management (38 percent of the habitat or 0.4 percent of the GMNF), there are some differences across alternatives. Alternative A provides the highest allocation at 1,737 acres, while Alternative B provides the smallest allocation at about 1,119 acres (24 percent of the habitat). Alternatives C, D and E are in the middle,

allocating around 1,300 acres to special designations or lands unsuitable for timber management (28 percent of the habitat). Consequently, all alternatives appear to provide at over a quarter of the available potential habitat in allocations that are most likely to provide high quality habitat and support sensitive species. While these differences are small relative to the size of the Forest and the available habitat, they may become meaningful with time as these habitats develop more complex structure and older characteristics.

In the remaining rich woods habitat not allocated to special designations, as well as in the small, unidentified patches scattered elsewhere on the Forest, several management activities have the potential to affect habitats and impact individual plants and populations, regardless of alternative. All harvesting techniques reduce canopy closure, and could, therefore, alter the moisture and temperature regimes, reducing habitat suitability for some rich northern hardwood species. Over the long-term, Spectrum modeling indicates that lands where timber harvesting could occur will have at least 68% crown closure across all alternatives, and remaining lands are likely to have greater amounts. Consequently, most forested stands will have what are considered closed canopies, regardless of alternative.

Even-age regeneration harvest reduces canopy closure more than other methods. Although high quality hardwood stands, such as enriched sites, are usually managed with uneven-age methods, some even-age regeneration harvest could occur in this habitat. Such harvest could attract deer, moose, and other herbivores in an area, increasing the risk of herbivory. Thinnings and uneven-age harvests could also occur in rich northern hardwood habitat and could alter habitat suitability, though not as much as even-age regeneration harvesting would. Summer logging is more likely to directly impact individual plants than winter logging, and because these areas tend to be moist during the growing season they are typically logged in the winter, which reduces the potential for direct impacts. Standards and guidelines for protection of TES species and conservation of significant ecological features will reduce the potential for harvest to impact sensitive species and old or high quality examples of this habitat.

Construction of roads or trails for forest or recreation management needs can lead to loss of soil productivity through soil compaction and altering local hydrology. The productivity of these sites often depends on adequate soil moisture. With changes to the moisture status of soils in these habitats their suitability can be degraded and populations or individuals lost. Agency policy and Forest-wide guidance require protection of soil productivity and seek to minimize soil compaction and erosion, which will help to mitigate some of these impacts. Seepy areas within rich northern hardwood stands would be treated as forested wetlands and would be provided protections noted for that habitat group, including limitations on both ground disturbing activities and reduction of canopy cover.

Trails and roads, both new and existing, can also bring people into these habitats, and have the potential to result in illegal off-trail use, user-created trails, and trampling and collection of plants. This is the case for all alternatives, as levels of recreational development are not specified in the revised Plan, but are based on demand and site-specific analysis. Increased use and maintenance of existing trails in and near rich northern hardwood habitats can have similar effects, reducing habitat suitability for some species and affecting the survival of individual plants or populations. Roads and trails can also serve as vectors for the spread of NNIS, and can lead to increased risk of infestation by NNIS like garlic mustard in these habitats. Guidance for protection of TES species should prevent the placement of new trails or roads near known populations of sensitive plants, and should help to mitigate some of these impacts. Monitoring of sensitive species required in the revised Plan will help the Forest identify circumstances where use levels are impacting sensitive plants, and adjustments in management like relocation of trails can be undertaken to help mitigate these impacts. Standards and guidelines for NNIS prevention and control in all habitats should reduce the potential for indirect impacts to habitats and species.

#### Populations: Direct and Indirect Effects

Only one species in this habitat group, *Eupatorium purpureum*, has all or most of its occurrences on the GMNF in special designations across Alternatives B through E, and none do in Alternative A. *Blephilia hirsuta*, *Carex aestivalis*, *Cypripedium parviflorum* var. *pubescens*, *Juglans cinerea*, *Panax quinquefolia*, *Platanthera orbiculata*, and *Ribes triste* have at least one population within a protected designation across

at least Alternatives B through E. All of these designations emphasize protection of unique resource values, including sensitive plants and their habitats, that are associated with the designations, and in some cases are the reasons for their designation. These designations also allow management as needed to maintain habitat for sensitive species. Consequently, these designations provide ecological conditions that are likely to contribute to the long-term viability of these species.

*Collinsonia canadensis*, *Dryopteris felix-mas*, and *Phegopteris hexagonoptera* have no populations within special designations. Several activities discussed above have the potential to affect individual plants within rich northern hardwood habitats, particularly those habitats not in special designations. Forest-wide guidance on protection of TES species, as well as habitat protection measures associated with soil, riparian areas, conservation of significant features, and prevention and control of NNIS, should mitigate potential impacts to populations of the species of this habitat group that are not in protected areas under any of the alternatives.

Factors outside of Forest's control (genetic isolation, orchid biology, disease, and illegal collection) may result in the decline of several species, regardless of alternative or management area allocation. *Juglans cinerea* is declining dramatically due to a disease that is beyond the control of the Forest to manage, beyond maintaining existing individuals and populations that show signs of resistance. Revised Plan guidance encourages cooperation with other agencies in halting the decline in this species, including establishment of seed orchards or small plantations to help test butternut resistance. *Collinsonia canadensis* and *Eupatorium purpureum* are known from only one population on the Forest, are quite isolated, and are not expected to occur outside of the current sites from which they are known. Metapopulation dynamics for these species may be precluded, and they can easily be lost due to a random natural event. In addition, *Eupatorium purpureum* grows adjacent to a woods road that receives recreational use and serves as access to an inholding, which means the road cannot be eliminated and it will always remain quite vulnerable. The roots of *Panax quinquefolius* are highly desirable and are illegally collected, regardless of prohibitions on collecting sensitive species. Collection pressure has reduced population numbers in Vermont and the GMNF to levels that some botanists believe are not currently, or soon will not be, viable (SVE Upland Forest Plants Panel 2002). *Cypripedium parviflorum* var. *pubescens* and *Platanthera orbiculata* may also be susceptible to collection as well as herbivory, and they have a suite of life history characteristics particular to orchids that make them vulnerable to loss.

While all species in this group are associated with a habitat that is generally rare on the Forest, some appear to be doing better than others. *Carex aestivalis* and *Ribes triste* are both considered by botanists to be doing fairly well on the Forest (SVE Upland Forest Plants Panel 2002), although they are only known from a few locations. Both species have wider tolerances than some others in the group for certain characteristics of the habitat like moisture or composition, and *Ribes triste* is thought to be overlooked. On the other hand, the remaining species are thought to be at moderate risk or declining toward potential loss of viability. *Collinsonia canadensis*, *Eupatorium purpureum*, *Juglans cinerea*, and *Panax quinquefolius* are all expected to decline over the next 20 years to levels that may jeopardize their viability for reasons noted earlier and beyond the control of the Forest (SVE Upland Forest Plants Panel 2002). *Blephilia hirsuta*, *Cypripedium parviflorum* var. *pubescens*, *Dryopteris filix-mas*, *Phegopteris hexagonoptera*, *Platanthera orbiculata*, and *Uvularia perfoliata* are considered vulnerable and moderately at risk due to small populations or locations adjacent to roads or trails, among other factors already mentioned. A combination of protective designations and Forest-wide standards and guidelines, along with required monitoring and adjustments in management, will contribute to the maintenance of ecological conditions needed for long-term viability of the species in this habitat group, to the extent the Forest can control those conditions.

#### Cumulative Effects

A little over half of the species in this group have less than 20 documented occurrences in Vermont, including *Blephilia hirsuta*, *Carex aestivalis*, *Collinsonia canadensis*, *Dryopteris felix-mas*, *Eupatorium purpureum*, *Phegopteris hexagonoptera*, and *Uvularia perfoliata*. Two of the remaining species, *Juglans cinerea* and *Panax quinquefolius*, are declining rapidly across their ranges. The taxonomy of the yellow

lady's slippers has changed over the last decade, and Vermont has not reevaluated its population numbers for *Cypripedium parviflorum* var. *pubescens*.

While the GMNF provides important habitat for species in this habitat group, only two of the twelve species in this group, *Blephilia hirsuta* and *Ribes triste*, have more than half of their populations on the Forest. This is likely due to the greater quantity and wider distribution of calcareous soils off the Forest in the Champlain and Vermont Valleys and the Taconic Mountains. Aside from these two species, the GMNF is not likely to ever become a source of populations for species in this habitat group, although populations off the Forest may have the potential to repopulate the sites in which these species are currently found if they are lost. Populations of *Juglans cinerea* may provide sources of resistant genotypes due to their comparative isolation from the bulk of the populations in Vermont, although most butternut trees sampled on the GMNF are infected.

Within the ecological regions of the GMNF, it is likely that there will be an increase in human development and land management activities, which contribute to habitat fragmentation, habitat simplification, loss of pollinators, loss of seed dispersers, high deer numbers, and spread of NNIS. These factors are likely to adversely affect populations of sensitive plants of this group off the Forest in these regions. Timber harvesting of all types will occur across the regions, as will recreational use and development, with impacts off-Forest similar to those discussed for the GMNF. The cumulative effects of harvest and development on and off the Forest would likely be a reduction in the availability and quality of rich northern hardwood forests on the landscape. Whether this reduction would impact viability of sensitive species is uncertain. In areas where rich northern hardwoods occur as larger patches of habitat, impacts to small stands may not greatly reduce suitable habitat, while major land conversions in these habitats can have dramatic negative effects. Such conversions have occurred in the valleys, and few rich northern hardwood forests exist in these areas in large patches. Small patches of habitat with limited distribution, as is the case in the Green Mountains and in the fragmented valleys, can mean that the loss of a few patches could affect species distribution and metapopulation interactions, but the likelihood of actually impacting suitable acres is less. The combination of Forest-wide guidance on TES protection, soil and water protection, and significant ecological features protection, along with the relatively unfragmented forest landbase on the GMNF that is aging and recovering from historical land uses, should prevent a loss of viability of species in this group within the planning area, although interactions with off-Forest populations could be affected. Other factors beyond the Forest's control, as noted earlier, may lead to losses of viability, but actions on the Forest under any of the alternatives are not expected to cause these losses, and may help to limit losses of some species. Over the long-term, rich northern hardwood forest habitat on the GMNF may become a refugium for some of these species as development off-Forest continues to eliminate their habitat.

#### **Species Determination and Rationale**

The revised Plan and its alternatives may impact individuals, but are not likely to cause a trend toward federal listing or loss of viability for any sensitive plant species associated with this habitat. Protection of known occurrences in protective designations, project mitigation measures that prevent or minimize impacts during vegetation management, and management of recreational uses within and near rich northern hardwoods should minimize negative impacts under all alternatives. However, populations of several species in this group will continue to be vulnerable to Forest management actions and impacts, such as changes in canopy closure, changes in hydrology, trampling, and potential infestations of NNIS, as well as conditions beyond the Forest's control, such as disease, illegal collection, and losses due to small single populations and very limited habitat on the Forest. Monitoring and management actions to conserve this habitat and its associated species are key factors in mitigating the impacts within the Forest's control, and without them some species of this habitat are less likely to persist on the GMNF.

### **Species of Dry, Low-elevation Forests and Woodlands**

#### **Habitat Description and Distribution**

These habitats include a combination of several natural communities that together comprise most of the Oak-Pine-Northern Hardwood Formation (Thompson and Sorenson 2000). These natural communities

have affinities to central hardwood forests more typical of southern New England, where oaks, hickories, pines, and hemlock are more common. Mesic communities that are part of this forest formation are not included here, but are included in rich northern hardwoods if they have rich characteristics. Particular natural communities that are part of this group and are known from the GMNF include red pine forest and woodland, pitch pine-oak-heath rocky summit, dry oak forest and woodland, dry oak-hickory-hophornbeam forest, and transition hardwood talus woodland (Thompson and Sorenson 2000). White pine-red oak-black oak forests are not documented from the Forest, although they may occur along the escarpment in areas that have not been inventoried. This habitat often grades from forest to woodland to open rocks and ledges; however the discussion for this group does not consider the more open rocky environment, which is discussed under the rock and cliff habitat group. Drier occurrences of the oak-northern hardwood forest community, which is considered part of the Northern Hardwood Formation and a mesic forest type, do occur in these lower elevation forests, and can also be considered part of this group. Areas with dry, low elevation forest and woodland habitat, or with RFSS associated with this habitat, that have been identified as ecologically significant include Chandler Ridge, Rattlesnake Point, Mount Moosalamoo, Burnt Mountain, Bryant Mountain Hollow, Bryant Mountain, Bristol Cliffs, and Elephant Mountain.

This habitat occurs at low elevations in warm, dry areas, and is therefore most common along the western and eastern sides of Vermont – not the mountains. Most of this habitat on the Forest is restricted to the western edge of the Forest along the Champlain and Vermont Valleys (the escarpment area noted earlier), the lower elevations of the Taconics, and warmer stream valleys that extend into the mountains from the west. In addition, because of the geographical coincidence of these warmer low elevation environments with bedrock formations of limestone and dolomite, many species strongly associated with warm, dry, calcareous environments are restricted to these habitats. Forest stand inventories on the GMNF suggest that there are about 3,800 acres of these dry low elevation forest and woodland habitats on the GMNF, or about one percent of National Forest System lands. Mapping of ecological land unit groups (ELUGs) and Landtype Associations (LTAs) on the GMNF (Burbank 2004; Burbank et al. 1999) based on physiographic, bedrock, and land cover data for the Northern Appalachians, suggest that there is potential for an additional 4,000-8,000 acres of these habitats on the Forest, although these areas have not been identified during stand inventories. Some of these ELUGs and LTAs may indicate potential conditions that have not developed yet, or that may have been converted through historical land use to a different habitat.

This habitat group includes both forest and woodland types, but is generally characterized by relatively open or thin canopies. Communities within this group can have thin or sparse understories as well, although some, like the pitch pine-oak-heath rocky summit community, have a well-developed shrub layer. Substrates are generally sandy or coarse, and can be deep or very shallow to bedrock, but do not usually have a hardpan. Soil chemistry varies from acidic to calcareous, although the majority of species associated with this type require calcareous substrates. These habitats are often associated with disturbance regimes that occur at relatively high frequencies when compared to northern hardwood forests. These disturbances are important in maintaining the thin canopies and sparse understories, which many species of this group prefer. It is likely that fire was an important disturbance factor in these environments.

Table 5-11 shows the 17 RFSS plants that are sensitive on the GMNF with affinities for dry, low-elevation forests and woodlands, including their specific habitat requirements, biological factors that may be important to viability, and numbers on the GMNF. This information is based on literature reviews and discussions with botanists regarding these species, and is documented in species summaries (USDA 2004) and the project file.



<b>Table 5-11: RFSS Plants of Dry Low-elevation Forest and Woodland Habitats and factors affecting their viability</b>			
<b>Species</b>	<b>Habitat Requirements</b>	<b>Biological Factors</b>	<b>Occurrences (extant or historical)</b>
<i>Aureolaria pedicularia</i> var. <i>pedicularia</i>	Dry, often rocky, sometimes calcareous, open oak and oak-pine forests, woodlands, and clearings, generally below 1,600'	Annual, so seed dispersal important; insect pollinated; hemiparasitic on oak roots; genetic isolation	2 extant and 2 historical in VT; 1 extant in cumulative effects analysis area, on GMNF
<i>Cardamine parviflora</i> var. <i>arenicola</i>	Open or mostly open, dry, rocky, calcareous exposed ledges and outcrops at low to middle altitudes, with oak and hickory, with thin soils and sparse shrubs and herbs	Annual/biennial, so seed dispersal important	3 extant and 11 historical from VT; 3 extant and 7 historical in the cumulative effects analysis area; 2 extant on GMNF
<i>Carex aestivalis</i>	Calcium or nutrient-enriched rocky forests, usually of oak-northern hardwoods or rich northern hardwoods, generally on mesic soils and steep slopes, generally below 2,500', in fairly open understories or associated with gaps		9 extant and 1 historical in VT; 7 extant and 1 historical in cumulative effects analysis area; 4 extant on GMNF
<i>Clematis occidentalis</i> var. <i>occidentalis</i>	Generally calcareous substrates, including shallow, well-drained soils, exposed rock and cliffs, and bases of cliffs, within open or partly open oak-dominated forests and woodlands, sometimes rich northern hardwoods; below 2,500' elevation	Possible animal dispersal of seeds	16 extant and 18 historical in VT; 15 extant and 15 historical in the cumulative effects analysis area; 3 extant on GMNF
<i>Conopholis americana</i>	Dry, enriched soils of mature, oak-dominated forests	Obligate parasite on roots of oak trees; requires mycorrhizae presence on oak roots; long-lived; reproduces after 4 years; herbivory by deer and bear	13 extant and 6 historical in VT; 12 extant and 4 historical in cumulative effects analysis area; 2 extant on GMNF
<i>Desmodium paniculatum</i>	Dry, low altitude, open forests and woodlands, of oaks and oak-northern hardwoods, sometimes on calcareous substrates; also in clearings and along woodland edges and roads	Animal dispersal of seeds; genetic isolation	9 extant and 13 historical in VT; 9 extant and 8 historical in cumulative effects analysis area; 1 extant and 1 historical on GMNF
<i>Draba arabisans</i>	Open or mostly open, dry, calcareous rocks or cliffs, in crevices, with sparse shrubs and herbs, associated with sparse oak, hickory, and pine woodlands, generally below 2,500' elevation	Historical over-collecting by botanists	7 extant and 13 historical in VT; 6 extant and 11 historical in the cumulative effects analysis area; 1 extant on GMNF

<b>Table 5-11: RFSS Plants of Dry Low-elevation Forest and Woodland Habitats and factors affecting their viability</b>			
<b>Species</b>	<b>Habitat Requirements</b>	<b>Biological Factors</b>	<b>Occurrences (extant or historical)</b>
<i>Eupatorium purpureum</i>	Moist, calcium-enriched soils of rich northern hardwoods and various mixed oak-hardwood forest types, generally below 1,000', generally in partial or full shade	Genetic isolation; deer herbivory	12 extant and 7 historical in VT; 11 extant and 3 historical in cumulative effects analysis area; 1 extant on GMNF
<i>Isotria verticillata</i>	Dry-mesic to mesic non-calcareous oak forests, in soils with deep leaf litter, under light to moderate shade, with a sparse understory, generally below 1,300' elevation	Vegetative reproduction; pollination by bees; mycorrhizal relationship; genetic isolation; collection	6 extant and 2 historical in VT; 6 extant and 1 historical in cumulative effects analysis area; 1 extant on GMNF
<i>Lespedeza hirta</i>	Dry, sandy or rocky, open woodlands, fields, thickets, and woods edges, associated with oak-pine-hardwood woodlands; generally below 1,500'		3 extant and 3 historical in VT; 2 extant and 3 historical in the cumulative effects analysis area; 1 extant adjacent to GMNF
<i>Nabalus trifoliolatus</i> (= <i>Prenanthes trifoliolata</i> )	Dry, sandy or rocky soil of open oak-pine forests, woodlands, clearings, and thickets, generally at lower elevations	Genetic isolation	1 extant and 6 historical in VT; 1 extant and 3 historical in cumulative effects analysis area; 1 extant on GMNF
<i>Phegopteris hexagonoptera</i>	Calcium or nutrient enriched, warm, moist, light soils of rich northern hardwood and oak-northern hardwood forests, generally below 1,500', under a high canopy	Slow vegetative reproduction	14 extant and 12 historical in VT; 14 extant and 8 historical in cumulative effects analysis area; 3 extant and 1 historical on GMNF
<i>Pinus rigida</i>	Sandy and gravelly soils, rock outcrops, dry slopes with excessive drainage, in association with oak and pine woodlands; generally below 1,500' elevation; requires full sun and mineral soil for germination, but will form a forest or woodland type	Prolific seeder	Patches in Champlain and Connecticut River Valleys in VT; unknown number in cumulative effects analysis area; 3 extant on GMNF
<i>Platanthera orbiculata</i>	Calcium or nutrient enriched northern hardwood and oak forests at low elevations, or moist boreal conifer woods or swampy woods at moderate elevations	Moth pollination; infrequent flowering; dependent on soil mycorrhizae; browsed heavily by deer and slugs; collectors; long-lived	At least 30 records for VT; uncertain # of records from cumulative effects analysis area; 4 extant and 4 historical on GMNF
<i>Pyrola chlorantha</i>	Dry, calcium-enriched deciduous or coniferous forests at moderate elevations, or alkaline softwood swamps at lower elevations, in deep humus, moss, or conifer litter	Bee pollination; mycorrhizal relationship	At least 13 records for VT; at least 8 records from the cumulative effects analysis area; 1 historical on GMNF

<b>Table 5-11: RFSS Plants of Dry Low-elevation Forest and Woodland Habitats and factors affecting their viability</b>			
<b>Species</b>	<b>Habitat Requirements</b>	<b>Biological Factors</b>	<b>Occurrences (extant or historical)</b>
<i>Solidago squarrosa</i>	Open or partially shaded, acidic or calcareous, dry, rocky woods, ledges, and outcrops, generally below 2,500' elevation	Hybridization with <i>Solidago macrophylla</i> ; deer herbivory	2 extant and 23 historical in VT; 2 extant and 21 historical in the cumulative effects analysis area; 1 extant and 1 historical on GMNF
<i>Uvularia perfoliata</i>	Circumneutral, generally calcium-enriched, mesic soils of rich northern hardwood, oak-northern hardwood, and mixed forests on southern aspects, generally below 1,000', generally in dappled shade	Colonial plant with vegetative reproduction; insect pollination; low seed output; 2-year seed dormancy before germination	6 extant and 4 historical in VT and cumulative effects analysis area; 1 extant on GMNF

### **Limiting Factors and Threats**

The primary limiting factor for this habitat on the Forest is its distribution. Being restricted to the western edge of the GMNF and the sandier and drier portions of the Vermont Valley and slopes of the Taconics, it represents only a very small proportion of the landbase. Consequently, this habitat is not well-distributed across the planning area. In addition, habitat quality for species of this group is further restricted by the presence or absence of calcareous substrates, higher light conditions, sparse understories, drier soils, and the ecological processes and disturbances that maintain those conditions.

It is suspected that the woodland character of several sites of this habitat group on the Forest was either created through sheep farming in the late 19<sup>th</sup> century, or through fire occurrence. There is documentation of fire along the western escarpment ecosystems, but only one site has a documented detailed fire history that includes both historic and prehistoric time periods (Mann et al. 1994). Visits by Forest Service staff to several of the woodland sites along the escarpment north of Brandon in 1999 found some occurrences of fire scars on trees and charcoal in the soil, as well as the presence of pitch pine, a tree well-known for its association with natural fire regimes. Some of these sites that are woodland now appear to be succeeding to forest, and for many of the species in this group that conversion will limit suitable habitat. It may be that without fire or some other form of disturbance that maintains the woodland character, the tendency towards succession to closed forest is strong in all but the most extreme site conditions in these areas.

Habitat degradation and alteration, alteration of disturbance regime, genetic isolation, herbivory, and invasive species are the primary threats that impact this habitat and the rare species that use it. Areas of this habitat that are on gentle slopes and flats are targeted for development, particularly where there are deep sandy soils. Opening the forest canopy can be beneficial to several species in this group but detrimental to others, particularly those with symbiotic relationships with mature oak trees. Tree harvesting, skidding, and the building and maintenance of roads and trails can affect soil structure and directly impact plants. These habitats are often considered operational for summer logging because they tend to be dry year-round. Because the environment within the woodland habitats in this group can be harsh, the impacts of a given activity may also have more dramatic effects on species than in more mesic conditions. Suppression of fire, elimination of insect pests, and prohibitions against tree removal can lead to development of closed canopies and succession over time to more mesic conditions, making habitat unsuitable for most of the species in this group. Timber harvesting and creation of roads and trails can increase competition with NNIS, and can increase browse for deer, encouraging herbivory. Many of the communities in this habitat group occur as small, widely scattered patches, which can lead to genetic isolation of populations.

**Management Direction Pertinent to Dry, Low-elevation Forest and Woodland Habitat**

Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to sensitive plants within these habitats. There is no species-specific management direction in the revised Forest Plan for most of the sensitive plants of this habitat group. Because some of the communities within this group are generally unproductive and can only grow small stature or sparse stands of trees, they are usually not considered suited for timber management. The communities that consist of forested stands dominated by oak or white pine are often suited for timber management. Consequently, timber and vegetation management standards and guidelines would also apply to these areas. While this guidance indicates under what circumstances different silvicultural techniques would be used, and how they would be implemented, there is no specific silvicultural guidance for this habitat. Oak-dominated habitats are identified as a composition objective in the revised Plan, to be maintained across one to five percent of the Forest. These habitats also have an age-class distribution objective for regenerating, young, mature, and old age classes, although this objective only applies to stands that are suited for timber management that are managed using even-age methods. These objectives emphasize the young and mature age classes, with small proportions in the regenerating and old age classes.

Management direction within Ecological Special Areas and Wilderness are applicable to these habitats because some of the identified important sites for communities or RFSS in this group occur within these areas across all alternatives. These management area designations provide emphasis and guidance on protecting habitat for TES species, and prohibit or limit many ground-disturbing and canopy-altering activities. Most of these areas also allow management to maintain habitat for TES species. In addition, Wilderness Study Areas also provide similar protections and emphasis as these areas, although they currently are not known to harbor rare plants of this habitat group. Direction within the Green Mountain Escarpment Special Area is also applicable, as the remaining important sites for this habitat group are within this management area across most alternatives. The Green Mountain Escarpment Special Area emphasizes the maintenance and restoration of oak and pine-dominated communities along the escarpment through reintroduction of fire and use of other vegetation management tools. Management direction for the remaining management areas also provides protections for TES species.

**Potential Management Effects****Habitat: Direct and Indirect Effects**

Timber harvesting can have a direct impact on this habitat through activities that disturb the ground, like road building, skidding logs, and compaction of soil, and activities that increase the amount of sunlight below the canopy, like regeneration harvests. These impacts apply regardless of alternative, although they apply to only a subset of this habitat that is productive enough for timber management. Ground disturbance can destroy individuals or populations of sensitive plants through trampling, can encourage invasion by NNIS, can destroy deep litter or humus layers, and can alter soil properties through compaction making the soil less suitable for germination. Ground disturbance also can be beneficial for several species in this group by exposing mineral soil needed for germination, and by removing competing ground vegetation. Thinning or removing the canopy can cause soil desiccation and can lead to increased competition from weedy species and NNIS. It can also increase the amount of browse available for herbivores, which can be attracted to these harvest areas and browse on sensitive plants. However, as most species in this group are associated with partially open or thin canopies as well as dry soil conditions, increases in light and dry conditions may also be beneficial for many of these species by improving conditions for germination and growth. These effects are mitigated by revised Plan guidance on protection of TES species, as well as standards and guidelines that minimize soil damage from erosion and compaction, and govern the control and prevention of NNIS.

The use of fire within this habitat can also have impacts similar to timber harvesting, regardless of alternative. Prescribed fire and/or wildland fire are allowed under all management areas. Fire can destroy weak populations and humus layers. It can also eliminate other ground vegetation and provide opportunities for colonization by NNIS. However, as for timber harvesting, ground disturbance and removal of competing vegetation can also open up the habitat to colonization and expansion by several of the sensitive plants in this group. *Pinus rigida* in particular is strongly associated with a fire disturbance

regime and habitats maintained by fire. Protection measures and project mitigation for TES species are also likely to mitigate these impacts by ensuring that weak populations are not burned, by gauging the timing of burns to facilitate positive responses by sensitive species, and by monitoring recovery of the burned sites to ensure NNIS don't become established.

Construction, maintenance, and use of roads and trails can have similar impacts to timber harvesting through ground-disturbance and canopy alteration. This is the case for all alternatives, as levels of recreational development and use are not specified in the revised Plan, but are based on demand and site-specific analysis. Generally along trails the canopies are thin and not completely open, so canopy impacts may be minimal; often species in this group find more suitable habitat nearer to trails than away from trails because there is more light and less vegetation there. These activities can also bring people into these habitats, and have the potential to result in illegal off-trail use, user-created trails, and trampling and collection of plants. Roads and trails can also serve as vectors for the spread of NNIS, and can lead to increased risk of infestation by NNIS like garlic mustard in these habitats. Guidance for protection of TES species should prevent the placement of new trails or roads near known populations of sensitive plants, and should help to mitigate some of these impacts. Monitoring of sensitive species required in the revised Plan will help the Forest identify circumstances where use levels are impacting sensitive plants, and adjustments in management like relocation of trails can be undertaken to help mitigate these impacts. Standards and guidelines for NNIS prevention and control in all habitats should reduce the potential for indirect impacts to habitats and species.

Perhaps the most important impact that the revised Plan can have on this habitat and its species is in emphasizing the management of oak-hardwood and oak-pine forests. All alternatives place at least 64 percent of these dry, low elevation forests within management areas that allow timber harvesting, which, while having the potential for negative impacts, are more likely than other management areas to support the continued existence of these types of forests. Natural successional processes, and loss of fire as an important disturbance regime in these forests, are likely to lead, over the next 20 years and the long term, to loss of suitability of many of these habitats for sensitive species. In many cases, having timber harvesting available as one of several tools to manage these forests, particularly in places where using prescribed burning would not be safe or desirable, will create more opportunities for maintenance and expansion of this habitat, which is an objective of the revised Plan. It is also important to have areas where natural succession is allowed to proceed within these habitats, in order to better understand how natural processes change these GMNF habitats over time.

The alternatives do vary in terms of the amount of this habitat that is placed in allocations where its management is emphasized, the amount of this habitat where timber management and prescribed fire are allowed, and the amount of this habitat that is allocated to special designations where natural processes dominate. Under the Green Mountain Escarpment Special Area designation, these habitats are particularly targeted for management actions in order to continue their existence and enhance their characteristics, particularly for associated sensitive species. Management actions can range from prescribed fire to non-commercial vegetation management to commercial timber sales. Eighty percent of the inventoried oak-hardwood and oak-pine habitats on the GMNF are found within the escarpment landscape, where this management area is focused. Of the sensitive plants associated with this habitat, all are found on the escarpment, and 70 percent are restricted to this landscape. Alternative A has no allocation to the Green Mountain Escarpment Special Area, while Alternatives D and E have the most, 17,710 acres and 14,436 acres, respectively, or four percent of the GMNF. Alternatives B and C offer a small amount of Green Mountain Escarpment Special Area management emphasis, with 2,894 and 8,488 acres, respectively, or between one and two percent of the GMNF. Consequently, under Alternatives D and E, this habitat and its associated species have the highest likelihood of persisting and expanding in size.

Of the oak-dominated stands on the GMNF, as noted earlier, all alternatives allocate at least 64 percent of them to management areas that allow timber harvesting. This is the case for Alternative B, while Alternatives C and D allocate 70 percent to such management areas, and Alternative E allocates 71 percent. These differences reflect the allocation of certain portions of the escarpment, with the oak

stands associated with them, to Ecological Special Area, Remote Backcountry Forest, or Wilderness Study Area designations under Alternatives B through E. These designations help to provide reference areas within this habitat to study natural succession and disturbance processes in these communities. However, under Alternatives B through E, some of these areas are likely to lose suitable habitat over the long term, and sensitive species associated with these areas may decline. There are no known sensitive species associated with the portion of the escarpment that is allocated to Remote Backcountry Forest or Wilderness Study Area under Alternatives B through E. Therefore, these allocations may result in loss of suitable habitat and possible undiscovered populations, but not in the loss of documented populations. The Ecological Special Area designations within the escarpment do hold sensitive species, but management area standards and guidelines encourage management for TES species and associated habitat. Consequently, in these areas, TES species known to occur will be protected and will be managed to ensure their continued existence, including habitat management as needed.

#### Populations: Direct and Indirect Effects

About half of the species in this habitat group, including *Aureolaria pedicularia*, *Cardamine parviflora* var. *arenicola*, *Clematis occidentalis*, *Draba arabisans*, *Eupatorium purpureum*, *Nabalus trifoliolatus*, *Pyrola chlorantha*, and *Solidago squarrosa*, have all or most of their populations within special designations, including cRNA/RNA, Ecological Special Area, and Wilderness. Several sites within these designations provide such extreme rocky oak forest habitat (for example Rattlesnake Point) that natural processes that would lead to declines in suitability will take much longer than the life of the Plan. Another three species, *Carex aestivalis*, *Desmodium paniculatum*, and *Platanthera orbiculata*, have at least one population within these designations. All of these designations emphasize protection of unique resource values, including sensitive plants and their habitats, that are associated with the designations, and in some cases are the reasons for their designation. These designations also allow management as needed to maintain habitat for sensitive species. Consequently, these designations provide ecological conditions that are likely to contribute to the long-term viability of these populations, although with limited habitat management these populations may not expand.

Six of the species in this group, including *Conopholis americana*, *Isotria verticillata*, *Lespedeza hirta*, *Phegopteris hexagonoptera*, *Pinus rigida*, and *Uvularia perfoliata*, do not have any populations within special designations. For these species, populations are documented from parts of the escarpment that are managed under Alternative A as Diverse Forest Use or Diverse Backcountry, and under Alternatives B-E as Green Mountain Escarpment Special Area. Under any of these management areas, vegetation management is allowed, and has the potential to cut or trample individuals, reduce leaf litter, provide too much light, and encourage competition from NNIS and other plants. Vegetation management within these areas can also be used as a tool to create habitat conditions that support the viability of these species, by removing competing vegetation, providing increased light levels, and preparing a seedbed. The Green Mountain Escarpment Special Area emphasizes management to maintain and restore these habitats and species. While the remaining management areas do not emphasize these habitats, Forest-wide guidance for sensitive species and associated habitat will tend to mitigate the negative impacts and foster the potential beneficial impacts of vegetation management in these areas. Consequently, impacts to these species are expected to be minor, possibly beneficial, and implementation of any of the alternatives is not likely to cause a loss of viability.

Factors outside of Forest's control (for example, genetic isolation, life history characteristics, collection) may result in the decline of several species, regardless of alternative or management area allocation. This is particularly true for *Aureolaria pedicularia*, *Nabalus trifoliolatus*, and *Pinus rigida*, all of which are expected to decline slightly over the next 20 years to levels that may jeopardize their viability, regardless of alternative (USDA 2004). *Eupatorium purpureum* is also at moderate risk and has the potential to decline to levels that may not be viable. All of these species except *Pinus rigida* are each known from only one population of a single or very few plants, in vulnerable locations adjacent to trails or roads. *Pinus rigida* is at risk due to its reliance on high light conditions and sandy or rocky mineral soil in warm climates for reproduction. Most environments on the GMNF are too moist to support this species. *Aureolaria pedicularia* has a documented decline on the GMNF as well, which is suspected to be related to a closing canopy. This species also has a partially parasitic relationship with the roots of oak trees,

from which it derives some nutrients to survive. While management on the GMNF can help to maintain habitat for these species and reduce or eliminate impacts related to management activities, recreational use, NNIS, the isolation of these populations and the potential for a random natural event to eliminate them may lead to a loss of viability, regardless of management actions. Given the revised Plan guidance on protection of TES species, as well as guidance on monitoring of these populations to identify when management actions may be needed, it is unlikely that management actions on the Forest will cause a loss of viability for these species.

Other species in this group have low population numbers and additional vulnerabilities that warrant concern. *Conopholis americana*, *Desmodium paniculatum*, *Draba arabisans*, *Isotria verticillata*, *Lespedeza hirta*, *Phegopteris hexagonoptera*, *Platanthera orbiculata*, *Pyrola chlorantha*, *Solidago squarrosa*, and *Uvularia perfoliata* all have fewer than five populations on the Forest, and most have only one or two. Most of these species only find habitat of marginal suitability on the GMNF. These species may become genetically isolated or be lost due to a natural event such as ground disturbance by animals or windthrow. *Conopholis americana* is an obligate parasite of oak roots, particularly those of mature trees. Death of the oak trees on which this plant is a parasite, from insects, disease, or harvesting, can lead to loss of viability. *Isotria verticillata* and *Platanthera orbiculata* may also be susceptible to collection and herbivory, and they have a suite of life history characteristics particular to orchids that make them vulnerable to loss. *Draba arabisans* has been over collected by botanists historically. *Pyrola chlorantha* is only known historically from the Forest at one site, and although its presence has not been recently confirmed, it has not been located elsewhere on the Forest. These species are considered to be at moderate risk, although they are expected to remain somewhat stable over the next 20 years (SVE Oak-Pine Plants Panel 2002; SVE Upland Forest Plants Panel 2002; SVE Open Rocks Plants Panel 2002). A combination of protective designations, habitat management, and revised Plan guidance on TES species protection, along with required monitoring and adjustments in management, will contribute to the maintenance of ecological conditions needed for long-term viability of these species, to the extent the Forest can control those conditions.

While all species in this group are associated with a habitat that is generally rare on the Forest, some appear to be doing better than others. *Carex aestivalis* and *Clematis occidentalis* are both considered by botanists to be doing fairly well on the Forest (SVE Upland Forest Plants Panel 2002; SVE Oak-Pine Plants Panel 2002), although they are only known from a few locations. *Carex aestivalis* has a wider tolerance than some others in the group for moisture levels, and can be found in rich northern hardwood habitats as well. *Clematis occidentalis* grows in places that are less vulnerable to human disturbances but stay naturally open, particularly talus woodland slopes. Forest-wide guidance protecting TES species and their associated habitats will likely maintain conditions needed for long-term viability of these species.

#### Cumulative Effects

The cumulative effects analysis area for this habitat includes the GMNF proclamation boundary, the Champlain and Vermont Valleys, and the Taconic Mountains, which serve as a source of propagules for most of the species that occur in these habitats along the western side of the Forest. With the exception of *Pinus rigida* and *Platanthera orbiculata*, all of the species in this habitat group have fewer than 20 records in Vermont, and over half have fewer than ten records. While the GMNF provides important habitat for species in this habitat group, only two of the 17 species in this group, *Cardamine parviflora* var. *arenicola* and *Nabalus trifoliolatus*, have more than half of their populations on the Forest. This is likely due to the greater quantity and wider distribution of dry, low elevation forests and woodlands, particularly those on calcareous substrates, off the Forest in the Champlain and Vermont Valleys and the Taconic Mountains. Aside from these two species, the GMNF is not likely to ever become a source of populations for species in this habitat group, although populations off the Forest may have the potential to repopulate the sites in which these species are currently found if they are lost.

Within the Champlain and Vermont Valleys and the lower slopes and hills of the Taconics, it is likely that there will be an increase in development and management activities, which contribute to habitat fragmentation, habitat simplification, loss of pollinators, loss of seed dispersers, population isolation, high deer numbers, and spread of NNIS. Historical and current agricultural practices of allowing grazing in

these woodlands have contributed to loss of populations and habitat suitability. These factors are likely to adversely affect populations of sensitive plants of this group off the Forest in these regions. Timber harvesting of all types will occur across the analysis area, as will recreational use and development, with impacts off-Forest similar to those discussed for the GMNF. While harvesting can have beneficial effects for species of this group, there is no requirement for surveying for TES species or maintaining habitat for these species on private lands. Some harvesting does take place on State lands, where management is obligated to consider effects on state-listed species.

The cumulative effects of harvesting without consideration of TES species, combined with habitat loss and degradation off the Forest, would likely be a reduction in the availability and quality of these dry, warm, oak-dominated forests on the landscape, along with continued isolation of populations and loss of metapopulation interactions. These changes have the potential to impact viability of sensitive species on the Forest, mainly because the Forest populations tend to be small and isolated as well. While habitat on the GMNF will continue to be marginal, all of the alternatives are likely to provide a habitat sink for source populations off the Forest. Alternatives D and E are likely to provide the most opportunities to maintain and expand this habitat on the Forest, although viability for the species in this group will continue to be marginal due to the limited amount of habitat that can be managed this way on the Forest. The combination of Forest-wide guidance on TES protection, as well as emphasis on oak management, should prevent a loss of viability of species in this group within the planning area, although interactions with off-Forest populations could be affected. Other factors beyond the Forest's control, as noted earlier, may lead to losses of viability, but actions on the Forest under any of the alternatives are not expected to cause these losses, and may help to limit losses of some species.

#### **Species Determination and Rationale**

The revised Plan and its alternatives may impact individuals, but are not likely to cause a trend toward federal listing or loss of viability for any sensitive plant species associated with this habitat. Protection of known occurrences in protective designations, project mitigation measures that prevent or minimize impacts during vegetation management, and management of recreational uses within and near this habitat should minimize negative impacts under all alternatives. However, populations of several species in this group will continue to be vulnerable to direct and indirect impacts related to Forest management activities, such as changes in canopy closure, trampling, soil disturbance, herbivory, and potential infestations of NNIS, as well as conditions beyond the Forest's control, such as species life history traits, illegal collection, and losses due to small populations and very limited habitat on the Forest. Monitoring and management actions to conserve this habitat and its associated species are key factors in mitigating the impacts within the Forest's control, and without them some species of this habitat are less likely to persist on the GMNF.

### **Species of Conifer Forests**

#### **Habitat Description and Distribution**

This is a broad habitat category that includes most forest types that are made up primarily of conifers – spruce, fir, and hemlock – and includes the natural communities montane spruce-fir forest, lowland spruce-fir forest, and hemlock forest (Thompson and Sorenson 2000). In some cases it includes areas where conifers are mixed with hardwoods, as in hemlock-northern hardwood forest, red spruce-northern hardwood forest, montane yellow birch-red spruce forest, and small patch communities of boreal and cold air talus woodlands. These types are included here as their long-term successional tendencies are toward conifer dominance. Forests dominated by pines or pines mixed with oaks are included in the dry, low-elevation forest habitat section, and wet conifer forests and seeps are included in the forested wetland habitat section. Areas of conifer forest, or with RFSS associated with this habitat, that have been identified as ecologically significant include Grout Pond, Stratton Mountain, French Hollow, The Burning, Green Mountain Ridge, White Rocks, Killington, North Pond, The Cape RNA, Mt. Horrid, Mt. Moosalamoo, Bryant Mountain, Middlebury Gap, Abbey Pond, and Bristol Cliffs.

Within the Green Mountains, the distribution of this habitat is primarily defined by climate. Most of this habitat is montane spruce- fir forest, which tends to occur over large areas above 2,500 feet in elevation.



Hemlock tends to be restricted to elevations below 1,800 feet along river valleys and along the escarpment. These habitats tend to be concentrated on the GMNF, which manages most of the upper elevations in the southern Green Mountains. Conifer forests dominated by spruce, fir, or hemlock occupy about 25,300 acres or 6 percent of the Forest; while those mixed with hardwoods (called “mixedwood” in timber inventories) occupy about 39,000 acres or about 10 percent of the Forest. Natural tendencies defined by ecological landtypes (ELTs) and ecological land unit groups (ELUGs), which represent potential natural vegetation on the Forest based on soils, geomorphology, landforms, elevation, and land cover, suggest that conifer forests would be expected to occupy about 15 to 25 percent of the GMNF, and mixedwood forests would occupy about 40 to 60 percent of the Forest (see also the Vegetation section of Chapter 3 in the DEIS). It is likely that turn-of-the-century harvesting of red spruce in particular reduced the number of acres of conifer forest and mixedwood forests with a spruce component on the GMNF, although some of these areas are recovering and have abundant spruce and fir reproduction. Areas in the Taconics are not observed to be recovering as well from early harvesting of spruce, with little evidence of reproduction in parts of the GMNF.

Conifer habitats are generally very shaded, and over long periods of time can develop deep soil organic layers or humus. However, trees in these habitats, particularly spruce and fir, often tip over during high winds due to their shallow roots, forming gaps. In the mountains, these can form waves called “fir waves”, as trees tip over onto each other like dominos. Because high winds are frequent in the mountains, these habitats can be quite dynamic, with gaps forming frequently in exposed areas. Species affiliated with this habitat often have a wide tolerance for changes in light, although some prefer full shade. Climate is generally cool or cold in these habitats, with the warmer climates associated with hemlock forests. In the mountains, clouds often descend to encompass montane spruce-fir forests, providing a steady supply of moisture that contributes to wet, spongy conditions on the forest floor. This source of water is important for many plants of these forests (Thompson and Sorenson 2000). Soils are usually acidic and leached of nutrients, although in some places they are shallow to more mineral rich bedrock. This is particularly important for the plants of this habitat group, which are all associated with calcium-enriched soils.

Table 5-12 shows the four RFSS plants that are sensitive on the GMNF with affinities for conifer forests, including their specific habitat requirements, biological factors that may be important to viability, and numbers on the GMNF. This information is based on literature reviews and discussions with botanists regarding these species, and is documented in species summaries (USDA 2004) and the project file.

Table 5-12: RFSS Plants of Conifer Forest Habitats and factors affecting their viability			
Species	Habitat Requirements	Biological Factors	Occurrences (extant or historical)
<i>Platanthera orbiculata</i>	Calcium or nutrient enriched northern hardwood and oak forests at low elevations, or moist boreal conifer woods or swampy woods at moderate elevations	Moth pollination; infrequent flowering; dependent on soil mycorrhizae; browsed heavily by deer and slugs; collectors; long-lived	At least 30 records for VT; uncertain # of records from cumulative effects analysis area; 4 extant and 4 historical on GMNF
<i>Pyrola chlorantha</i>	Dry, calcium-enriched deciduous or coniferous forests at moderate elevations, or alkaline softwood swamps at lower elevations, in deep humus, moss, or conifer litter	Bee pollination; mycorrhizal relationship	At least 13 records for VT; at least 12 records from the cumulative effects analysis area; 1 historical on GMNF
<i>Ribes triste</i>	Mostly calcium-enriched, seepy or swampy, deciduous or coniferous woods, or subalpine conifer forests; partial sun to full shade.	Vegetative reproduction; seeds may be animal dispersed; historical eradication due to hosting white pine blister rust	At least 22 records in VT, of which at least 12 are extant; 17 records in cumulative effects analysis area; 10 extant and 3 historical on GMNF
<i>Sorbus decora</i>	Fertile or calcium-enriched, mesic, subalpine spruce-fir forests, edges, and openings, generally in partial sun, generally above 2,500'	Moose herbivory	At least 6 extant and 5 historical in VT; 5 extant and 4 historical in cumulative effects analysis area; 4 extant on GMNF

### **Limiting Factors and Threats**

In general, conifer forest habitat is well distributed across the Forest, and is not limiting to most species of this habitat. As a component of conifer forests, hemlock forests are much more limited, restricted to the western escarpment and river valleys up to about 1,800 feet elevation. Montane spruce-fir forests tend to be concentrated at the higher elevations, in larger contiguous blocks to the north, and in small and large patches toward the south. This habitat is far patchier in Vermont than in New Hampshire or Maine, both during presettlement times and currently. Mixedwood forests are about as common and well distributed as conifer forests on the GMNF, occurring in large contiguous areas along mid-elevation slopes and in patches of small and large size on moderate elevation plateaus.

Both conifer and mixedwood forests are less prevalent than might be expected based on natural tendencies, generally as a result of land use history, particularly harvesting of red spruce near the turn of the 20<sup>th</sup> century. It is likely that many existing hardwood stands were once conifer or mixedwood stands, and are slowly recovering and gaining softwoods, particularly in the understory where they would not yet define the type of the stand. Other stands may have lost the capacity to support conifer forests for quite some time, either through loss of conifer seed sources, competitive exclusion of softwoods by northern hardwoods, or some other change in ecological conditions. The extent to which softwood trees are excluded from or slow to return to some original sites due to changes in the ecology of these sites will limit the future extent of this habitat. The vulnerability of red spruce to climate warming, diseases like *Armillaria* root rot, and atmospheric deposition and resulting aluminum toxicity also will limit the future extent of conifer and mixedwood habitat on the GMNF.

The primary limiting factor for sensitive species of this habitat appears to be soil chemistry. The species in this group are generally associated with fertile or calcium-enriched substrates, which are extremely

limited in the higher elevations and most of the mountains, although more common along the escarpment. Bedrock maps do not recognize calcareous formations within the upper elevations of the GMNF, although some formations are known to include small bands of calcium-enriched rock, which are not mapped. Other factors that limit habitat quality for some species include light levels and soil moisture, with species associated with both high or low light levels, and high or low moisture levels.

Development, vegetation management, road and trail use and maintenance, insects and disease, atmospheric deposition, and global climate changes are the primary threats affecting this habitat and the species affiliated with it. Urban and rural developments have removed areas of low elevation conifer forest, and recreation and commercial development have altered high elevation habitat in some areas. Regeneration timber harvest on certain ecological land types can result in conversion of some conifer forest to mixed or hardwood forest, making it less suitable for some species in this group. This has happened historically during spruce harvesting around the turn of the century. Harvest also alters forest age and canopy conditions, which may affect habitat suitability for some species. Use and maintenance of roads and trails can directly impact plants in this group, most of which gravitate toward edges. Roads and trails can also alter site hydrology, making habitat less suitable for some species. Insect infestations and disease, such as *Armillaria* root rot fungus, can also alter canopy conditions by creating areas of less shade. Atmospheric deposition and global climate change may reduce or change these habitats in the long-term.

#### **Management Direction Pertinent to Conifer Forest Habitat**

Forest-wide goals, objectives, standards, and guidelines that conserve RFSS in general, as well as agency policy, apply to sensitive plants within these habitats. There is no species-specific management direction in the revised Forest Plan for most of the sensitive plants of this habitat group. Forested wetland habitats that may be embedded within conifer forests are protected by water quality and riparian area guidance found in the revised Plan and noted in the previous wetland habitat discussions. Conifer forests above 2,500 feet elevation are generally less productive, tend to be on steep ground, and so are usually not considered suitable for timber harvesting. Those below 2,500 feet elevation are often considered suitable for timber management. Consequently, timber and vegetation management standards and guidelines would also apply to these areas. While this guidance indicates under what circumstances different silvicultural techniques would be used, and how they would be implemented, there is no specific silvicultural guidance for this habitat. Composition objectives indicate the desire to manage toward natural tendencies, which suggests that stands tending toward increased conifer composition will be managed to support those tendencies. Standards and guidelines for deer wintering areas also apply to this habitat. Deer wintering habitat is comprised of conifer stands that are used by deer for thermal cover in the winter. Revised Plan guidance specifies certain desired attributes of these areas, including general maintenance and enhancement of this cover habitat, representation of at least six 10-year age classes, specifications for stocking, age, species, and size of trees, restrictions on winter activities in these areas including a preference for summer logging, and browse adjacent to wintering areas.

Management direction within RNAs/cRNAs, Ecological Special Areas, Wilderness, White Rocks NRA, Remote Backcountry Forest, and Wilderness Study Areas are applicable to these habitats because a majority of the identified important conifer forest habitats or sites for RFSS in this group occur within these areas across all alternatives. Some areas that are shown on bedrock maps as providing calcareous rock substrates are also included in these management areas, although their extent in these areas varies by alternative. All of these management area designations provide emphasis and guidance on protecting habitat for TES species, and prohibit or limit many ground disturbing activities that can lead to potential habitat quality degradation. Most of these areas also allow management to maintain habitat for TES species. Management direction for the remaining management areas also provides protections for TES species.

#### **Potential Management Effects**

##### **Habitat: Direct and Indirect Effects**

Alternatives are not expected to differ in terms of the amount of conifer or mixedwood habitat that is available on the Forest. The distribution of this habitat is primarily defined by climate, and is slowly

recovering from land use history and late 19<sup>th</sup> century harvesting of red spruce. The revised Plan has identified objectives to provide 15 to 25 percent of the GMNF in conifer communities, which is approximately at natural tendencies (see the Vegetation section of Chapter 3, DEIS). The proportion of conifer forests on the GMNF currently falls below both this objective and natural tendencies. However, some of the mixedwood forests are expected to become conifer dominated over the long-term, regardless of management, and are likely to help boost the proportion of conifer forests closer to objectives and expected tendencies. Over the next 20 years, and over the long term, it is likely that many of these forests will continue to recover, slowly increasing the proportion of softwoods that once may have been found within these stands. The revised Plan not only has objectives in general for conifer composition, but also has guidance regarding perpetuation and enhancement of conifer habitats for deer wintering areas, as well as objectives for management toward natural conversion of hardwoods to conifers based on natural tendencies. Consequently, it is unlikely that management activities within alternatives will substantially change these overall trends of slow recovery of softwoods, or move the proportion of softwood and mixedwood stands anywhere but closer to natural tendencies and the objective range.

The alternatives do vary in regard to the relative risks to conifer and mixedwood habitat from the different management area allocations and associated types of management activities that may occur within them. Allocations of conifer habitat to special designations or lands unsuitable for timber management can help contribute to the development and maintenance of high quality conifer habitat for sensitive species. In these areas, including the Alpine/Subalpine Special Area, RNA/cRNA, Ecological Special Area, Remote Backcountry Forest, Wilderness, White Rocks NRA, and Wilderness Study Areas, natural processes will dominate the landscape over large areas, and these processes help to maintain high quality habitat for species associated with this group by limiting the risks they face as a result of logging, herbivory, and recreational use. While all of the alternatives allocate around half of the conifer habitat and over a third of the mixedwood habitat to special designations or lands unsuitable for timber management, there are some differences across alternatives. Half of the areas identified above as significant ecological examples of this habitat are allocated to special designations under Alternative A, and almost three-quarters are so allocated under Alternatives B through E. Alternative A provides the most mixedwood habitat and the least conifer habitat to special designations or unsuitable lands, combined for a total of 41,500 acres or 46 percent of the habitat. In contrast, Alternative D allocates the most conifer habitat and a moderate amount of mixedwood habitat to special designations, combined for a total of 41,900 acres or 47 percent. Alternative B provides a small amount of conifer habitat and the least amount of mixedwood habitat in special designations, for a total of 37,800 acres or 42 percent. Alternatives C and E are close to Alternative D, providing around 41,000 acres or 46 percent of the habitat in special designations or unsuitable lands. Consequently, Alternatives C through E allocate more than 40 percent of the available habitat, and most of the significant ecological examples of this habitat, to designations that are most likely to provide high quality habitat and support sensitive species, and may provide some slight advantages over the other two alternatives in terms of risk to sensitive species of this habitat, as well as habitat development. While these differences are small relative to the size of the Forest and the available habitat, they may become meaningful with time as these habitats develop more complex structure and older characteristics.

In the remaining conifer forest habitat not allocated to special designations, several management activities have the potential to affect habitats and impact individual plants and populations, regardless of alternative. Within the portions of the remaining habitat that are considered suitable for timber management, logging activities are likely to occur over the next several decades. All harvesting techniques reduce canopy closure, and could, therefore, alter light, moisture and temperature regimes, reducing habitat suitability for some species of conifer forests. Over the long-term, Spectrum modeling indicates that lands where timber harvesting could occur will have at least 68% crown closure across all alternatives, and remaining lands are likely to have greater amounts. Consequently, most forested stands will have what are considered closed canopies, regardless of alternative.

Even-age regeneration harvest reduces canopy closure more than other methods, and even-age methods are likely to occur in this habitat, particularly in deer wintering areas. Such harvest could attract deer, moose, and other herbivores in an area, increasing the risk of herbivory. Even-age regeneration

harvests also remove most of the mature age class, and have the potential to lead to loss of conifers if no conifer seed sources or young conifer seedlings and saplings remain after the harvest. Thinnings and uneven-age harvests could also occur in conifer habitat and could alter habitat suitability, though not as much as even-age regeneration harvesting would. Summer logging is more likely to directly impact individual plants than winter logging, and can lead to the disturbance or loss of deep humus layers and disruption of local hydrology. Because summer logging is preferred in deer wintering areas, these areas are where direct impacts are most likely. However, many conifer stands tend to be moist during the growing season, and so they are typically logged in the winter, which reduces the potential for direct impacts. Standards and guidelines for protection of TES species and conservation of significant ecological features, as well as guidance on protection of water, soil, and riparian areas, will reduce the potential for harvest to impact this habitat or the sensitive species affiliated with it. Revised Plan guidance on conifer composition and deer wintering habitat will reduce the likelihood that existing conifer habitats will be lost due to harvesting.

Construction, maintenance, and use of roads and trails, including ski trails, can have similar impacts to timber harvesting through ground-disturbance and canopy alteration. This is the case for all alternatives, as levels of recreational development and use are not specified in the revised Plan, but are based on demand and site-specific analysis. Generally along trails the canopies are thin and not completely open, so canopy impacts may be minimal; some species in this group find more suitable habitat along trail or opening edges because they appear to prefer or tolerate partial shade. Others prefer full shade and even a thin or partially open canopy would reduce suitability. These activities can also bring people into these habitats, and have the potential to result in illegal off-trail use, user-created trails, and trampling and collection of plants. Roads and trails can also serve as vectors for the spread of NNIS, and can lead to increased risk of infestation by NNIS in these habitats. Guidance for protection of TES species should prevent the placement of new trails or roads near known populations of sensitive plants, and should help to mitigate some of these impacts. Monitoring of sensitive species required in the revised Plan will help the Forest identify circumstances where use levels are impacting sensitive plants, and adjustments in management like relocation of trails can be undertaken to help mitigate these impacts. Standards and guidelines for NNIS prevention and control in all habitats should reduce the potential for indirect impacts to habitats and species.

#### Populations: Direct and Indirect Effects

All species in this group have at least one population within a special designation under all alternatives. *Pyrola chlorantha* is only known historically from one site, but this site is also within a special designation under all alternatives. These designations, as noted earlier, emphasize protection of unique resource values, including sensitive plants and their habitats that are associated with the designations, and in some cases are the reasons for their designation. These designations also allow management as needed to maintain habitat for sensitive species. Consequently, these designations provide ecological conditions that are likely to contribute to the long-term viability of these populations.

*Sorbus decora* and *Ribes triste* appear to be doing well according to botanists familiar with these species in Vermont, and are likely to remain fairly stable across all alternatives (SVE Upland Forest Plants Panel 2002). Habitat availability is somewhat limiting, but *Sorbus decora* appears to be fairly persistent where it is found and tolerates habitat edges, while *Ribes triste* is thought to be overlooked. Consequently, actions that may occur under any of the alternatives are not likely to cause a loss of viability for these species.

*Platanthera orbiculata* and *Pyrola chlorantha* have vulnerabilities that suggest their viability is more at risk, although their populations on the GMNF are expected to remain relatively stable over the next 20 years (SVE Upland Forest Plants Panel 2002). These risks are associated with all alternatives, and although Alternatives C through E are slightly less risky for these habitats, the differences among the alternatives are not enough to change the overall vulnerability of these species to loss of viability. *Platanthera orbiculata* is susceptible to collection and herbivory, and has a suite of life history characteristics particular to orchids that make it vulnerable to loss. *Pyrola chlorantha* is only known historically from the Forest at one site near a trail, and although its presence has not been recently

confirmed, it has not been located elsewhere on the Forest. Activities that may increase deer, such as vegetation management in or near deer wintering areas, can lead to loss of individuals or populations, as can ground disturbing activities that disrupt deep leaf litter and humus. Habitat will be available within special designations where there are fewer risks, and management guidance for protection of TES would mitigate many of the remaining risks. However, individuals or populations may still be lost due to factors beyond the Forest's control, such as herbivory unrelated to forest management activities, illegal collection, genetic isolation from small, isolated populations, and life history characteristics that make establishment and persistence of populations less likely at any given site. A combination of protective designations, habitat management, and revised Plan guidance on TES species protection, along with required monitoring and adjustments in management, will contribute to the maintenance of ecological conditions needed for long-term viability of these species, to the extent the Forest can control those conditions.

#### Cumulative Effects

Of the species in this habitat group, only *Sorbus decora* has fewer than 10 records in Vermont, while the remaining three have between 10 and 30 records across the State. Two of the four species, *Sorbus decora* and *Ribes triste*, have more than half of their populations on the GMNF, while *Platanthera orbiculata* and *Pyrola chlorantha* are much more likely to occur off the Forest. All of these species are considered somewhat overlooked, however, and so it is not clear how important the GMNF is to the distribution of most of these species.

Assuming management occurs as proposed in the alternatives over the next 150 years, management and natural processes would result in an increase in the amount of conifer forest habitat on the Forest as mixedwood forests on sites ecologically suited to conifers gradually convert. These additional lands would support increased populations of most conifer forest species, including sensitive plants of these forests. Because this conversion would occur over many decades, changes in species populations would be gradual. In addition, this habitat will still be limited for most sensitive plants in this group due to their association with calcareous substrates.

Within the ecological regions of the GMNF, development and timber harvest activities that have resulted in the shifts in forest composition to lower proportions of conifers appear to have fewer impacts on this habitat. Forest Inventory and Analysis (FIA) data (Wharton et al. 2003) for Vermont indicate that spruce-fir forests have increased by 3% in the south and 13% in the northern part of the state, suggesting at least a state-wide slow recovery of these forests. On the other hand, mixed forests that include pine have been declining, likely due to maturation of forests where these species tend to be early successional. In addition, the trampling and disturbance effects of harvest and development on species in these habitats would be the same off-Forest as described for the GMNF, but more extensive, primarily because development is expected to continue in this habitat into the future (at ski areas and for wind and communication towers in particular). Because the Forest holds a high proportion of the conifer forest in the southern part of Vermont, the GMNF objectives for increasing conifer habitat and working toward natural tendencies becomes increasingly important to the species that rely on conifer habitats.

Over the long-term, off-Forest effects from development and loss of pine forests could result in some loss of suitable habitat, although the long-term trend toward increased conifer composition is expected to continue overall. It is expected that the viability of sensitive species affiliated with this group would remain stable, but some populations may decline off-Forest due to site-specific projects that result in loss of habitat. Given the overall habitat trend, though, it is likely that suitable habitat will become more abundant over the long term, and sensitive plants will become more able to accommodate these losses by establishing elsewhere. It is unclear at this time where the balance point will be between loss of habitat from development and increases in habitat from forest recovery, but it is likely several decades into the future at least, given that much of the spruce-fir habitat is on federal or state land where such development is limited. As development becomes more prevalent off public lands, the Forest may become more important as a refugium for some species. The combination of Forest-wide guidance on TES protection, soil and water protection, and significant ecological features protection, along with the relatively unfragmented forest landbase on the GMNF that is aging and recovering from historical land

uses, should prevent a loss of viability of species in this group within the planning area, although interactions with off-Forest populations could be affected over the long-term. Other factors beyond the Forest's control, as noted earlier, may lead to losses of viability, but actions on the Forest under any of the alternatives are not expected to cause these losses, and may help to limit losses of some species. Reductions in habitat off-Forest may ultimately limit the viability of some of these species, despite improved habitat on the Forest

#### **Species Determination and Rationale**

The revised Plan and its alternatives may impact individuals, but are not likely to cause a trend toward federal listing or loss of viability for any sensitive plant species associated with this habitat. Protection of known occurrences in protective designations, project mitigation measures that prevent or minimize impacts during vegetation management, and management of recreational uses within and near this habitat should minimize negative impacts under all alternatives. However, populations of several species in this group will continue to be vulnerable to direct and indirect impacts related to Forest management activities, such as changes in canopy closure, trampling, soil disturbance, herbivory, and potential infestations of NNIS, as well as conditions beyond the Forest's control, such as species life history traits, illegal collection, and losses due to small populations and very limited calcareous habitat on the Forest. Monitoring and management actions to conserve this habitat and its associated species are key factors in mitigating the impacts within the Forest's control, and without them some species of this habitat are less likely to persist on the GMNF.

## Literature Cited

- Acciavatti, R.E., T.J. Allen, and C. Stuart. 1992. The West Virginia tiger beetles (Coleoptera: Cicindelidae). *Cicindela* 24:45-78. (Not seen).
- Adamus, P.R. 1987. Atlas of breeding birds in Maine, 1978-1983. Maine Department of Inland Fisheries and Wildlife, Augusta, Maine.
- Andersen, E.M. and M.J. Lovallo. 2003. Bobcat and lynx *Lynx rufus* and *Lynx canadensis*. Pages 758-786 in G.A. Feldmamer, B.C. Thompson, and J.A. Chapman, editors. Wild mammals of North America: biology, management, and conservation. The Johns Hopkins University Press, Baltimore.
- Andrew, J.M. and J.A. Mosher. 1982. Bald eagle nest site selection and nesting habitat in Maryland. *Journal of Wildlife Management* 46:383-390.
- Anthony, R.G. and F.B. Isaacs. 1989. Characteristics of bald eagle nest sites in Oregon. *Journal of Wildlife Management* 53:148-159.
- AOU (American Ornithologists' Union). 1995. Fortieth supplement to the American Ornithologists' Union check-list of North American birds. *Auk* 112:819-830.
- Arendt, W.J. 1992. Status of North American migrant landbirds in the Caribbean region: a summary. Pages 143-171 in J.M. Hagan, III and D.W. Johnston, editors. Ecology and conservation of Neotropical migrant landbirds. Smithsonian Institution Press, Washington, D.C.
- Arvais, M., Bourgeois, J.-C., Lévesque, E., Daigle, C., Masse, D., and J. Jutras. 2002. Home range and movements of a wood turtle (*Clemmys insculpta*) population at the northern limit of its range. *Canadian Journal of Zoology* 80:402-408.
- Atwood, J.A., C.C. Rimmer, K.P. McFarland, S.H. Tsai, and L.N. Nagy. 1996. Distribution of Bicknell's thrush in New England and New York. *Wilson Bulletin* 108:650-661.
- Aubry, K.B.; Koehler, G.M.; and J.R. Squires. 1999. Ecology of Canada lynx in southern boreal forests. Pages 373-396 in Ruggiero et al. (editors). Ecology and conservation of lynx in the United States. USDA Forest Service, Rocky Mountain Research Station General Technical Report RMRS-GTR-30WWW. 480pp.
- Barbour, R.W. and W.H. Davis. 1969. Bats of America. University Press of Kentucky, Lexington, KY. 286 pp.
- BCI (Bat Conservation International). 2004a. Range map for *Myotis sodalis* on website <http://www.batcon.org>.
- BCI (Bat Conservation International). 2004b. Range map for *Myotis leibii* on website <http://www.batcon.org>.
- Beier, P. 1993. Determining minimum habitat areas and habitat corridors for cougars. *Conservation Biology* 7:94-108.
- Beier, P. 1995. Dispersal of juvenile cougars in fragmented habitat. *Journal of Wildlife Management* 59:228-237.
- Belwood, J.J. 1998. In Ohio's backyard: bats. Ohio Biological Survey Backyard Series No 1. 196 pp.
- Belwood, J.J. and J. H. Fullard. 1984. Echolocation and foraging behaviour in the Hawaiian hoary bat, *Lasiurus cinereus semotus*. *Canadian Journal of Zoology* 62:2113-2120.
- Best, T.L. and J.B. Jennings. 1997. Mammalian species, *Myotis leibii*. *The American Society of Mammalogists*. 547:1-6.
- Beverly, J., J.D. Kiser, and V. Brack Jr. 2002. A survey for eastern forest bats in two areas on Green Mountain National Forest, with emphasis on the federally endangered Indiana bat (*Myotis sodalis*): 30 August 2002. Report prepared for the USDA Forest Service, Green Mountain National Forest. Environmental Solutions & Innovations, LLC. Neon, Kentucky. 39 pp.
- Bishop, S.C. 1941. The salamanders of New York. New York State Museum Bulletin. No. 324. University of the State of New York, Albany, NY. pp. 365.
- Bogart, J.P. 1982. Ploidy and genetic diversity in Ontario salamanders of the *Ambystoma jeffersonianum* complex revealed through an electrophoretic examination of larvae. *Canadian Journal of Zoology*. 60:848-855.
- Bogart, J.P. and M.W. Klemens. 1997. Hybrids and genetic interactions of mole salamanders (*Ambystoma jeffersonianum* and *A. laterale*) (Amphibia: Caudata) in New York and New England. *American Museum Novitates* 3218. New York: American Museum of Natural History. 78 pp.
- Bolgiano, C. 1995. Do cougars exist in the East? *American Forests* 101:29-30, 58.



- Bolgiano, C. 2000. Field evidence of cougars in the East. Maryland Alliance for Greenway Improvement and Conservation web page. <http://www.magicalliance.org/articles.html>
- Borden, S.E. and C.C. Rimmer. 1998. Vermont Loon Recovery Plan. Unpubl. report. Vermont Institute of Natural Science, Woodstock, VT and Vermont Fish and Wildlife Department, Waterbury, VT.
- Bousquet, Y. and A. Larochelle. 1993. Catalogue of the Geadephaga (Coleoptera: Trachypachidae, Rhysodidae, Carabidae including Cicindelini) of America north of Mexico. Memoirs of the Entomological Society of Canada, No. 167. 397 pp.
- Brass, D.A. 1994. Rabies in bats: natural history and public health implications. Livia Press, Ridgefield, CT. pp 138, 143.
- Brodman, R. 1995. Annual variation in breeding success of two syntopic species of *Ambystoma* salamanders. Journal of Herpetology 29(1):111-113.
- Brodman, R. 1996. Effects of intraguild interactions on fitness and microhabitat use of larval *Ambystoma* salamanders. Copeia 1996(2):372-378.
- Brooks, R.J., Shilton, C.M., Brown, G.P., and N.W.S. Quinn. 1992. Body size, age distribution, and reproduction in a northern population of wood turtles (*Clemmys insculpta*). Canadian Journal of Zoology 70:462-469.
- Brown, B.T. and L.E. Stevens. 1997. Winter bald eagle distribution is inversely correlated with human activity along the Colorado River, Arizona. Journal of Raptor Research 31:7-10.
- Brunelle, P.M. 1999. Distribution of Damselflies and Dragonflies of Maine, United States. Northeastern Naturalist 6(2):95-118.
- Brunelle, P.M. 2004. Expert review, species viability evaluation (SVE) - odonate species. Edits made to the summary for *Somatochlora forcipata*, provided to the White Mountain National Forest on 18 October 2004.
- Buech, R.R. 1995. The wood turtle: its life history, status, and relationship with forest management. Proceedings of the 1995 NCASI Central-lake states regional meeting. pp.118-127.
- Buech, R.R. Hanson, L.G., and M.D. Nelson. 1997a. Identification of wood turtle nesting areas for protection and management. Pages 383-391 in Proceedings: conservation, restoration, and management of tortoises and turtles- an international conference.
- Buech, R.R., Nelson, M.D., Hanson, L.G., and B. Brecke. 1997b. Wood turtle habitat research. Abstract. Pages 475-476 in Proceedings: conservation, restoration, and management of tortoises and turtles- an international conference.
- Buehler, D.A. 2000. Bald Eagle *Haliaeetus leucocephalus*. The Birds of North America 506:1-40.
- Burbank, D., C. Ferree, P. Girton, J. Bove. 1999. Preliminary Landtype Associations – Biophysical Features, Green Mountain National Forest. Unpublished report. Green Mountain National Forest, Rutland, VT.
- Burbank, D.H. 2004. Special Area Assessment. Green Mountain National Forest, Rutland, VT, USA
- Burger, J. and S.S. Garber. 1995. Risk assessment, life history strategies, and turtles: could declines be prevented or predicted? Journal of Toxicology and Environmental Health 46:483-500.
- Burgess, N.M., D.C. Evers, and J.D. Kaplan. 2005. Mercury and other contaminants in Common Loons breeding in Atlantic Canada. Ecotoxicology 14:241-252.
- Cade, T.J. 1982. The falcons of the world. Cornell Univ. Press, Ithaca, NY. 192 p.
- Cade, T.J., J.H. Enderson, C.G. Thelander, and C.M. White. 1988. Peregrine falcon populations: their management and recovery. The Peregrine Fund Inc., Boise, ID, 949 pp.
- Cade, T.J., J.K. Enderson, L.F. Kiff, and C.M. White. 1997. Are there enough good data to justify delisting the American peregrine falcon? Wildlife Society Bulletin 25(3):730-738.
- Callahan, E.V., R.D. Drobney, and R.L. Clawson. 1997. Selection of Summer Roosting Sites by Indiana Bats (*Myotis sodalis*). Journal of Mammalogy 78:818-825.
- Carbyn, L.N. 1987. Gray wolf and red wolf. Pages 358-376 in M. Novak, J.A. Baker, M.E. Obbard, and B. Malloch, editors. Wild furbearer management and conservation in North America. Toronto: Ontario Ministry of Natural Resources and Ontario Trappers Association. Cited in R.M. DeGraaf and M. Yamasaki. 2001. New England wildlife: habitat, natural history, and distribution. University Press of New England, Hanover and London.
- Carle, F.L. 1994. Dragonflies and damselflies (Odonata) known to or likely to occur in Vermont. Report for VNNHP, Waterbury VT.

- Carroll, T.E., and D.W. Ehrenfeld. 1978. Intermediate-range homing in the wood turtle, *Clemmys insculpta*. *Copeia* 1978:117-126.
- Carroll, J.R. 1988. Bald Eagle *Haliaeetus leucocephalus*. Pages 100-101 in R.F. Anderle and J.R. Carroll, editors. The atlas of breeding birds in New York State. Cornell University Press. Ithaca, NY.
- CDC (Center for Disease Control). 2000. Update: West Nile virus activity – northeastern United States, 2000. Website: <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm4936a4.htm>, accessed 13 March 2003.
- Choate, J.R., J.K. Jones, Jr., and C. Jones. 1994. Handbook of mammals of the south-central states. Louisiana State University Press, Baton Rouge and London. Pp. 84-85.
- Christenson, B.L. 1981. Reproductive ecology and response to disturbance by common loons in Maine. MS Thesis. University of Maine, Orono.
- Clark, A. 1985. The tribe Alasmidontini (Unionidae: Anodontinae), part ii: *Lasmigona* and *Simpsonaias*. Smithsonian Contributions To Zoology, Number 399. 75 pp. Cited in NatureServe 2004c.
- Clawson, R.L. 1986. An investigation of the summer distribution and status of Indiana bats in Missouri. Final Report. Federal Aid Project W-13-R, Fish and Wildlife Res. Cen., Columbia, MO. 17 pp.
- Clawson, R.L. 2000. Implementation of a recovery plan for the endangered Indiana bat. In K.C. Vories and D. Throgmorton, editors. Proceedings of bat conservation and mining: a technical interactive forum held November 14-16, 2000. St. Louis, Missouri.
- Clawson, R.L. 2002. Trends in population size and current status. Pages in 2-8 in Kurta, A. and J. Kennedy, editors. 2002. The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, Texas.
- Cleland, D.T., P.E. Avers, W.H. McNab, M.E. Jensen, R.G. Bailey, T. King, and W.E. Russell. 1997. National Hierarchical Framework of Ecological Units. Published in, Boyce, M.S., Haney, A., editors. 1997. Ecosystem management applications for sustainable forest and wildlife resources. Yale University Press, New Haven, CT. pp. 181-200.
- Compton, B. W., Rhymer, J. M., and M. McCollough. 2002. Habitat selection by wood turtles (*Clemmys insculpta*): an application of paired logistic regression. *Ecology* 83(3):833-843.
- Conant, R. and J.T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Third Edition, Expanded. Houghton Mifflin Company, Boston. 616 pp.
- Constantine, D.G. 1979. An updated list of rabies-infected bats in North America. *Journal of Wildlife Diseases* 15:347.
- Cook, R.P. 1983. Effects of acid precipitation on embryonic mortality of *Ambystoma* salamanders in the Connecticut Valley of Massachusetts. *Biological Conservation* 27:77-88.
- Culver, M., W.E. Johnson, J. Pecon-Slaterry, and S.J. O'Brian. 2000. Genomic ancestry of the American Puma (*Puma concolor*). *The Journal of Heredity* 91:186-197.
- Cumberland, R.E. and J.A. Dempsey. 1994. Recent confirmation of a cougar, *Felis concolor*, in New Brunswick. *Canadian Field-Naturalist* 108:224-226.
- Currier, M.J.P. 1983. *Felis concolor*. *Mammalian Species* 200:1-7.
- Dalton, V. M. 1987. Distribution, abundance, and status of bats hibernating in caves in Virginia. *Virginia Journal of Science* 38:369-379.
- Davis, W.H., M.D. Hassell, and C.L. Rippey. 1965. *Myotis leibii leibii* in Kentucky. *Journal of Mammalogy* 46:683-684.
- DeGraaf, R.M. and M. Yamasaki. 2001. New England wildlife: habitat, natural history, and distribution. University Press of New England, Hanover, New Hampshire.
- DeGraaf, R.M., M. Yamasaki, W.B. Leak, and J.W. Lanier. 1992. New England wildlife: management of forested habitat. General Technical Report NE-144. USDA Forest Service, Northeastern Forest Experiment Station, Radnor, PA, USA. 271 pp.
- deMaynadier, P.G. and M.L. Hunter. 1998. Effects of silvicultural edges on the distribution and abundance of amphibians in Maine. *Conservation Biology* 12(2):340-352.
- deMaynadier, P.G. and M.L. Hunter. 2000. Road effects on amphibian movements in a forested landscape. *Natural Areas Journal* 20:56-65.
- Donna, K. 2004. Water Resource Assessment, Green Mountain National Forest Plan Revision. U.S. Department of Agriculture, Forest Service, Green Mountain National Forest, Rutland, Vermont.
- Dunkle, S.W. 1981. The Ecology and Behavior of *Tachopteryx thoreyi*, *Odonatologica* 10:189-199.

- Dunkle, S.W. 2000. Dragonflies through binoculars. A field guide to dragonflies of North America. Oxford University Press.
- Dunn, G.A. 1981. Tiger beetles of New Hampshire. *Cicindela* 13:1-28.
- Dunn, G.A., 1979. A New Hampshire population of *Cicindela ancocisconensis* exhibiting reduced elytral maculation. *Cicindela* 11:61-64.
- Dunn, J.P. and J.S. Hall. 1989. Status of cave-dwelling bats in Pennsylvania. *Journal of the Pennsylvania Academy of Science* 63:166-172.
- Eager, C., and M.B. Adams, eds. 1992. Ecology and decline of red spruce in the eastern United States. Springer-Verlag, New York.
- Erdle, S.Y. and C.S. Hobson. 2001. Current status and conservation strategy for the eastern small-footed myotis (*Myotis leibii*). Technical Report #00-19. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. 17 pp.
- Ernst, C.H. 1986. Environmental temperatures and activities in the wood turtle, *Clemmys insculpta*. *Journal of Herpetology* 20(2):222-229.
- Ernst, C.H. 2001a. An overview of the North American turtle genus *Clemmys* Ritgen, 1828. *Chelonian Conservation and Biology* 4:211-216.
- Ernst, C.H. 2001b. Some ecological parameters of the wood turtle, *Clemmys insculpta*, in southeastern Pennsylvania. *Chelonian Conservation and Biology* 4:94-99.
- Ernst, C.H., J.E. Lovich, and R.W. Barbour. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington. 578 pp.
- Evans, D. 1994. Bald Eagle *Haliaeetus leucocephalus*. Pages 373-374 in C.R. Foss, editor. The atlas of breeding birds of New Hampshire. Audubon Society of New Hampshire, Concord, NH.
- Evers, D.C., O.P. Lane, L. Savoy, and W. Goodale. 2004. Assessing the impacts of methylmercury on piscivorous wildlife using a wildlife criterion value based on the Common Loon, 1998-2003. Report BRI-2004-05 submitted to Maine Department of Environmental Protection. BioDiversity Research Institute, Gorham, ME.
- Faccio, S.D. 2003. Postbreeding emigration and habitat use by Jefferson and spotted salamanders in Vermont. *Journal of Herpetology* 37(3):479-489.
- Farmer, A., B. Cade, and D. Stauffer. 1997. A habitat suitability index model for the Indiana bat (*Myotis sodalis*). U.S. Geological Survey, Fort Collins, CO
- Farrell, R.F. and T.E. Graham. 1991. Ecological notes on the turtle *Clemmys insculpta* in Northwestern New Jersey. *Journal of Herpetology* 25(1):1-9.
- Feldhamer, G.A., B.C. Thompson, and J.A. Chapman. 2003. Wild mammals of North America: biology, management, and conservation. The Johns Hopkins University Press, Baltimore, MD. 1216 pp.
- Fichtel, C. 1985a. Common loon *Gavia immer*. Pages 30-31 in S.B. Laughlin and D.P. Kibbe, editors. The atlas of breeding birds of Vermont. Vermont Institute of Natural Science. University Press of New England, Hanover, New Hampshire.
- Fichtel, C. 1985b. Bald Eagle *Haliaeetus leucocephalus*. Pages 399-400 in S.B. Laughlin and D.P. Kibbe, editors. The atlas of breeding birds of Vermont. Vermont Institute of Natural Science. University Press of New England, Hanover, New Hampshire.
- Fichtel, C. and D.G. Smith. 1995. The Freshwater Mussels of Vermont. Vermont Fish and Wildlife Department, Nongame and Natural Heritage Program. Technical Report 18.
- Ford, W.M., J.M. Menzel, M.A. Menzel, J.W. Edwards. 2002. Summer roost-tree selection by a male Indiana bat on the Fernow Experimental Forest. USDA Forest Service, Northeastern Research Station, Research Note NE-378.
- Fowle, M.R., S.D. Faccio, and D.W. Blodgett. 2002. The 2002 breeding status and population dynamics of Peregrine Falcons in Vermont. Unpublished report. Vermont PEFA Season of 2002. National Wildlife Federation. Montpelier, VT.
- Franson, J.C., L. Sileo, N.J. Thomas. 1995. Causes of eagle deaths. Page 68 in: E.T. LaRoe, G.S. Farris, C.E. Puckett, P.D. Doran and M.J. Mac, editors. Our living resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. USDA – National Biological Service, Washington, D.C.
- Freda, J. 1986. The influence of acidic pond water on amphibians: a review. *Water, Air and Soil Pollution* 30:439-450.
- French, T.W. and L.L. Master. 1986. *Ambystoma jeffersonianum*. *Herp Review* 17(1):26.

- Fuller, T.K., W.E. Berg, G.L. Radde, M.S. Lenarz, and G.B. Joselyn. 1992. A history and current estimate of wolf distribution and numbers in Minnesota. *Wildlife Society Bulletin* 20:42-55.
- Garber, S.D. and J. Burger. 1995. A 20-yr. study documenting the relationship between turtle decline and human recreation. *Ecological Applications*. 5(4):1151-1162.
- Gardner, J.E. and E.A. Cook. 2002. Seasonal and geographic distribution and quantification of potential summer habitat. Pages 9-20 in Kurta, A. and J. Kennedy, editors. *The Indiana bat: biology and management of an endangered species*. Bat Conservation International. Austin, Texas.
- Gardner, J.E., J.D. Garner, and J.E. Hofmann. 1991a. Summer roost selection and roosting behavior of *Myotis sodalis* (Indiana bat) in Illinois. Final Report. Illinois Natural History Survey, Illinois Dept. of Conservation. Champaign, Illinois. 56pp.
- Gardner, J.E., J.D. Garner, and J.E. Hofmann. 1991b. Summary of *Myotis sodalis* summer habitat studies in Illinois: with recommendations for impact assessment. Special Report. Illinois Natural History Survey, Illinois Dept. of Conservation. Champaign, Illinois. 28pp.
- Garland, L.E. 1977. The effects of historical land use practices upon the abundance and distribution of deer in Vermont. Contract Report, Job IV-1: W-34-R-15, 1 July 1977.
- Gates, J.E., G.A. Feldhammer, L.A. Griffith, and R.L. Raesly. 1984. Status of cave-dwelling bats in Maryland. *Wildlife Society Bulletin* 12:162-169.
- Godin, A.J. 1977. *Wild mammals of New England*. The Johns Hopkins University Press, Baltimore, MD. 304 pp.
- Hall, J.S. 1962. A life history and taxonomic study of the Indiana bat, *Myotis sodalis*. *Sci Publ., Reading Pub. Mus. and Art Gallery* 12:1-68.
- Handley, C.O., Jr. 1991. Mammals. Pages 539-616 in *Virginia's endangered species: proceedings of a symposium*. K. Terwilliger, editor. McDonald and Woodward, Blacksburg, VA. 672 pp.
- Hanson, E.W., C.C. Rimmer, and J. Gobeille. 2004. The 2004 breeding status of Common Loons in Vermont. Unpublished report, Vermont Institute of Natural Science, Woodstock, VT and Vermont Fish and Wildlife Department, Waterbury, VT.
- Harding, J.H. 1997. *Amphibians and reptiles of the Great Lakes Region*. The University of Michigan Press, Ann Arbor. 378 pp.
- Harding, J.H., and T.J. Bloomer. 1979. The wood turtle, *Clemmys insculpta*...a natural history. *Herp. Bull., New York Herp. Soc.* 15(1):9-26.
- Harding, J.H. 1990. A twenty year wood turtle study in Michigan: implications for conservation. Manuscript for symposium on turtles and tortoises: conservation and captive husbandry, Chapman College, Orange, California. 9-12 August 1990.
- Harrison, D.J. and T.G. Chapin. 1998. Extent and connectivity of habitat for wolves in eastern North America. *Wildlife Society Bulletin* 26:767-775.
- Hilton, D.F.J. 1987. Odonata of peatlands and marshes in Canada. Pages 57-63 in D.M. Rosenberg and H.V. Danks, editors. *Aquatic insects of peatlands and marshes in Canada*. Mem., Ent. Soc. Canada, No. 140.
- Hitchcock, H.B. 1965. Twenty-three years of bat banding in Ontario and Quebec. *Canadian Field Naturalist* 79:4-14.
- Hitchcock, H.B., R. Keen, and A. Kurta. 1984. Survival rates of *Myotis leibii* and *Eptesicus fuscus* in southeastern Ontario. *Journal of Mammalogy* 65:126-130.
- Hofmann, J.E. 1996. Indiana bats in Illinois. Illinois Natural History Survey Reports, March-April 1996. Accessed on website: <http://www.inhs.uiuc.edu/chf/pub/surveyreports/mar-apr96/bats.html> on 11 March 1999.
- Horne, M.T. and W.A. Dunson. 1994a. Behavioral and physiological responses of the terrestrial life stages of the Jefferson salamander, *Ambystoma jeffersonianum*, to low soil pH. *Archives of Environmental Contamination and Toxicology* 27:232-238.
- Horne, M.T. and W.A. Dunson. 1994b. Exclusion of the Jefferson salamander, *Ambystoma jeffersonianum*, from some potential breeding ponds in Pennsylvania: effects of pH, temperature, and metals on embryonic development. *Archives of Environmental Contamination and Toxicology* 27:323-330.
- Hoving, C.L. 2001. Historical occurrence and habitat ecology of Canada lynx (*lynx canadensis*) in eastern North America. Unpublished MS Thesis in Wildlife Ecology. University of Maine. Orono, Maine. 200 pp.

- Hoving, C.L., R.A. Joseph, and W.B. Krohn. 2003. Recent and historical distributions of Canada lynx in Maine and the northeast. *Northeastern Naturalist* 10:363–382.
- Humphrey, S.R. 1978. Status, winter habitat, and management of the endangered Indiana bat, *Myotis sodalis*. *Florida Scientist* 41:65-76.
- Humphrey, S.R., A.R. Richter, and J.B. Cope. 1977. Summer habitat and ecology of the endangered Indiana bat (*Myotis sodalis*). *Journal of Mammalogy* 58:334-346.
- Hunter, M.L, A.J.K. Calhoun, and M. McCollough. 1999. Maine amphibians and reptiles. The University of Orono Press, Orono, Maine. 252 pp.
- Husar, S.L. 1976. Behavioral character displacement: evidence of food partitioning in insectivorous bats. *Journal of Mammalogy* 57:331-338.
- Jackson, S. 1994. The Jefferson Salamander. *Massachusetts Wildlife XLIV*(1):2-6.
- Jenkins, J. 1981. The Rare Plants of the Green Mountain National Forest and their Potential Habitats. Green Mountain National Forest, Rutland, Vermont, USA.
- Jenkins, J. 2003. Green Mountain National Forest High Altitude Pond Project. Green Mountain National Forest, Rutland, Vermont, USA.
- Johnson, A.H., and T.G. Siccama. 1983. Acid deposition and forest decline. *Environ. Sci. Technol.* 17:294A-305A.
- Johnson, A.H., S.B. McLaughlin, M.B. Adams, E.R. Cook, and D.H. DeHayes. 1992. Synthesis and conclusions from epidemiological and mechanistic studies of red spruce decline. Pages 387-411 in C. Eager and M.B. Adams, editors. *The ecology and decline of red spruce in the eastern United States*. Springer-Verlag, New York.
- Johnson, C.W. 1998. The nature of Vermont, introduction and guide to a New England environment. University Press of New England. Hanover, New Hampshire. 354 pp.
- Kath, J.A. 2002. An overview of hibernacula in Illinois, with emphasis on the Magazine Mine. Pages in 110-115 in Kurta, A and J. Kennedy, editors. 2002. *The Indiana bat: biology and management of an endangered species*. Bat Conservation International, Austin, Texas.
- Kaufmann, J.H. 1992. Habitat use by wood turtles in central Pennsylvania. *Journal of Herpetology* 26(3):315-321.
- Kaufmann, J.H. 1995. Home range and movements of wood turtles, *Clemmys insculpta*, in central Pennsylvania. *Copeia* 1995:22-27.
- Keys, Jr., J., C. Carpenter, S. Hooks, F. Koenig, W.H. McNab, W. Russell, and M.L. Smith. 1995. Ecological units of the eastern United States – first approximation (cd-rom). USDA Forest Service, Atlanta, GA. GIS coverage in ARC/INFO format, selected imagery, and map unit tables.
- Kibbe, D.P. 1985. Gray-cheeked thrush *Catharus minimus*. Pages 242-243 in S.B. Laughlin and D.P. Kibbe (editors). *The atlas of breeding birds of Vermont*. Vermont Institute of Natural Science. University Press of New England, Hanover, New Hampshire.
- Kiser, J.D., R.R. Kiser, V. Brack Jr., and E.R. Britzke. 2001. A survey for eastern forest bats on the Green Mountain and Finger Lakes National Forests, with emphasis on the federally endangered Indiana bat (*Myotis sodalis*). October 2001 report prepared for the USDA Forest Service. Environmental Solutions & Innovations, LLC. Neon, Kentucky. 60 pp.
- Kitchell, J.A. 1999a. Statement of Purpose and Reason *Draft Species Data Records, Felis concolor*. USFS Region 9.
- Kitchell, J.A. 1999b. Population Viability analysis *Falco peregrinus* species data form. USFS Region 9 Madison, WI.
- Klemens, M.W. 1989. The methodology of conservation: In Swingland, I. R. and M. W. Klemens, editors, *The Conservation Biology of Tortoises*. Occas. Pap. IUCN/SSC 5:1-4.
- Klemens, M.W. 1993. Amphibians and reptiles of Connecticut and adjacent regions. State geological and natural history survey of Connecticut Bulletin 112.
- Klyza, C.M. and S.C. Trombulak. 1999. The story of Vermont: a natural and cultural history. Middlebury College Press/University Press of New England, Hanover, NH, 240 pp.
- Kozie, K. 1999. Bald Eagle *Haliaeetus leucocephalus*. Statement of Purpose and Reason Draft Species Data Records. USFS Region 9 Minnesota and Wisconsin.
- Krutzsch, P.H. 1966. Remarks on silver-haired and Leib's bat in eastern United States. *Journal of Mammalogy* 47(1):121.

- Kurta, A. and J. Kennedy, editors. 2002. The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, Texas. 253 pp.
- Kurta, A. and J.O. Whitaker. 1998. Diet of the endangered Indiana bat (*Myotis sodalis*) on the northern edge of its range. American Midland Naturalist 140(2):280-286.
- Kurta, A., J. Kath, E.L. Smith, R. Foster, M.W. Orlick, and R. Ross. 1993. A maternity roost of the endangered Indiana bat (*Myotis sodalis*) in an unshaded, hollow, sycamore tree (*Platanus occidentalis*). American Midland Naturalist 130:405-407.
- Kurta, A., K.J. Williams, and R. Mies. 1995. Ecological, behavioural, and thermal observations of a peripheral population of Indian bats (*Myotis sodalis*). Pages 102-117 in R.M.R. Barclay and R.M. Brigham, editors. Bats and Forests Symposium, October, 19-21 1995, Victoria, British Columbia, Canada. Research Branch, British Columbia Ministry of Forests, Victoria. Working Paper 23/1996.
- Kurta, A., S.W. Murray, and D.H. Miller. 2002. Roost selection and movements across the summer landscape. Pages in 118-129 in Kurta, A. and J. Kennedy, editors. The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, Texas.
- Lambert, J.D. and K.P. McFarland. 2004. Projecting the effects of climate change on Bicknell's Thrush habitat in the northeastern United States. Unpublished report, Vermont Institute of Natural Science, Woodstock, VT.
- Lambert, J.D., K.P. McFarland, C.C. Rimmer, S.D. Faccio, and J.L. Atwood. 2005. A practical model of Bicknell's Thrush habitat in the Northeastern United States. Wilson Bulletin 117:1-11.
- Lanier, J. and R.M. Bollengier. 1994. Peregrine Falcon *Falco peregrinus*. Pages 60-61 in C.R. Foss, editor. The atlas of breeding birds of New Hampshire. Audubon Society of New Hampshire, Concord, New Hampshire.
- Laughlin, S.B. and D.K. Kibbe, editors. 1985. The atlas of breeding birds of Vermont. Vermont Institute of Natural Science. University Press of New England, Hanover, New Hampshire. 456 pp.
- Lee, M. and J. Arbuckle. 1987. Maine common loons: a glance back and an eye toward the future. Pages 167-176 In: P.I.V. Strong, ed. Papers from the 1987 conference on common loon research and management. Sept. 18-19, 1987. Ithaca, NY.
- Lehtinen, R.M., Galatowitsch, S.M., and J.R. Tester. 1999. Consequences of habitat loss and fragmentation for wetland amphibian assemblages. Wetlands 19(1):1-12.
- Leonard, J.G. and R.T. Bell, 1999. Northeastern tiger beetles. A field guide to tiger beetles of New England and eastern Canada. CRC Press, Boca Raton, FL. xii + 176 pp.
- MacGregor, J.R. and J.D. Kiser. 1999. Temperature variation at a maternity roost for *Myotis leibii* in a concrete bridge in eastern Kentucky. Abstract of paper presented at Fourth annual meeting of the Southeastern Bat Diversity Network, Wytheville, VA.
- Maier, T.J., M.N. Marchand, R.M. DeGraaf, and J.A. Litvaitis. 2002. A subterranean camera trigger for identifying predators excavating turtle nests. Herpetological Review. Herpetological Review 33(4):284 - 287.
- Mann, D.H., F.B. Engstrom, and J.L. Bubier. 1994. Fire history and tree recruitment in an uncut New England forest. Quarternary Research 42:206-215.
- Martin, M. 1979. Status report on Peregrine Falcon (*Falco peregrinus*) in Canada. Report submitted to the committee on the endangered wildlife in Canada (COSEWIC). B.C. Fish and Wildlife Branch, Victoria, BC. 48pp.
- Martin, S.M. 1997. Freshwater Mussels (Bivalvia:Unionoida) of Maine. Northeastern Naturalist 4:1-34.
- Mcintyre, J.W. and J.F. Barr. 1997. Common loon *Gavia immer*. Pages 1-32 in A. Poole and F. Gill, editors. The birds of North America, No. 313.
- McKelvey K.S., K.B. Aubrey, and Y.K. Ortega. 1999. History and distribution of lynx in the contiguous United States. Pages 207-264 in Ruggiero et al., editors). Ecology and conservation of lynx in the United States. USDA Forest Service, Rocky Mountain Research Station General Technical Report RMRS-GTR-30WWW. 480pp.
- Mech, L.D. 1974. Mammalian species, *Canis lupus*. The American Society of Mammalogists. 37:1-6.
- Menzel, M.A., J.M. Menzel, T.C. Carter, W.M. Ford, and J.W. Edwards. 2001. Review of the forest habitat relationships of the Indiana bat (*Myotis sodalis*). USDA Forest Service, Northeastern Research Station, GTR NE-284.
- Miller-Weeks, M., and D. Smoronk. 1993. Aerial assessment of red spruce and balsam fir condition in the Adirondack region of New York, the Green Mountains of Vermont, the White Mountains of New

- Hampshire, and the mountains of western Maine 1985-1986. USDA Forest Service, Northeastern Region NA-TP-16-93.
- Millsap, B.A., P.L. Kennedy, M.A. Byrd, G. Court, J.H. Enderson, and R.N. Rosenfield. 1998. Review of the proposal to de-list the American peregrine falcon. *Wildlife Society Bulletin* 26(3):522-538.
- Mladenoff, D.J., and T.A. Sickley. 1998. Assessing potential gray wolf restoration in the northeastern United States: a spatial prediction of favorable habitat and potential population levels. *Journal of Wildlife Management* 62:1-10.
- MNHP (Massachusetts Natural Heritage Program). 1989. Massachusetts Rare and Endangered Wildlife: Jefferson Salamander (*Ambystoma jeffersonianum*). Massachusetts Division of Fisheries and Wildlife. Boston, MA. 2 pp.
- Morin, P.J. 1984 Odonate guild composition: experiments with colonization history and fish predation. *Ecology* 65:1866-1873.
- Mowat, G., K.G. Poole, and M. O'Donoghue. 1999. Ecology of lynx in northern Canada and Alaska. Pages 265-306 in Ruggiero et al., editors. *Ecology and conservation of lynx in the United States*. USDA Forest Service, Rocky Mountain Research Station General Technical Report RMRS-GTR-30WWW. 480pp.
- NAPAP (National Acid Precipitation Assessment Program). 1992. Report to congress. U.S.Gov. Printing Office, Pittsburgh, PA.
- NatureServe. 2004a. NatureServe Explorer: An online encyclopedia of life. Version 4.0. NatureServe, Arlington, Virginia. Website <http://www.natureserve.org/explorer>, accessed July 28, 2004.
- NatureServe. 2004b. NatureServe Explorer: An online encyclopedia of life. Version 4.0. NatureServe, Arlington, Virginia. Website <http://www.natureserve.org/explorer>, accessed August 10, 2004.
- NatureServe. 2004c. NatureServe Explorer: An online encyclopedia of life. Version 4.0. NatureServe, Arlington, Virginia. Website <http://www.natureserve.org/explorer>, accessed August 12, 2004.
- Nelson, R.E and J.R. LeBonte. 1989. Rediscovery of *Cicindela ancocisconensis* T. W. Harris and first records for *C. scutellaris lecontei* Haldeman in Maine. *Cicindela* 21:49-54.
- NWF (National Wildlife Federation). 2004. Bald eagle restoration in the Champlain Basin. National Wildlife Federation, Montpelier, Vermont. 2 pp.
- Oatman, G.F. 1985. Peregrine falcon, *Falco peregrinus*. Page 411 in S.B. Laughlin and D.P. Kibbe, editors. *The atlas of breeding birds of Vermont*. Vermont Institute of Natural Science. University Press of New England, Hanover, New Hampshire.
- Oehler, J.D., and J.A. Litvaitis. 1996. The role of spatial scale in understanding responses of medium-sized carnivores to forest fragmentation. *Canadian Journal of Zoology* 74:2070-2079.
- Oliver, J.A. and J.R. Bailey. 1939. Amphibians and reptiles of New Hampshire exclusive of marine forms. In *Biological Survey of the Connecticut watershed*. New Hampshire Fish and Game Dept. Surv. Rep. 4:195-217.
- Osborn, R.G., C.D. Dieter, K.F. Higgins, and R.E. Usgaard. 1997. Bird flight characteristics near wind turbines in Minnesota. *American Midland Naturalist* 139:29-38.
- Ouellet, H. 1993. Bicknell's thrush: taxonomic status and distribution. *Wilson Bulletin* 105:545-572.
- Pagel, J.E. and D.A. Bell. 1997. Reply to Cade et al. regarding de-listing the American peregrine falcon. *Wildlife Society Bulletin* 25(3):739-742.
- Pagel, J.E., D.A. Bell, and B.E. Norton. 1996. De-listing the American peregrine falcon: is it premature? *Wildlife Society Bulletin* 24(3):429-435.
- Pagel, J.E., D.A. Bell, and M.L. Johnson. 1998. When is an endangered species recovery complete: is delisting the American peregrine falcon appropriate? Pages 463-474 in *Transactions of the 63<sup>rd</sup> North American Wildlife and Natural Resources Conference*.
- Palmer, R.S., editor. 1988. *Handbook of North American birds*. Volume 5. Yale University Press, New Haven, CT. 465 pp.
- Paquet, P.C. and L.N. Carbyn. 2003. Gray wolf, *Canis lupus* and allies. Pages 482-510 in G.A. Feldhamer, B.C. Thompson, and J.A. Chapman, editors. *Wild mammals of North America: biology, management, and conservation*. The Johns Hopkins University Press, Baltimore, MD.
- Parren. 2001. Wood turtle monitoring summary, Monkton/Hinesburg VT.
- Pashley, D.N., C.J. Beardmore, J.A. Fitzgerald, R.P. Ford, and W.C. Hunter. 2000. Partners in flight: conservation of the land birds of the United States. American Bird Conservancy. The Plains, VA.

- Peterson, A. 1986. Habitat suitability index models: bald eagle *Haliaeetus leucocephalus* breeding season. Biological Report 82(10.126). USFWS Washington, D.C.
- Peterson, J.M.C. 1988. Gray-cheeked thrush. Pages 320-321 in R.F. Anderle and J.R. Carroll, editors. The atlas of breeding birds in New York State. Cornell University Press. Ithaca, New York..
- Pfingsten, R.A. and F.L. Downs, editors. 1989. Salamanders of Ohio. College of Biological Sciences. Ohio State University, Columbus, Ohio. 315 pp.
- Pierce, B.A. 1985. Acid tolerance in amphibians. BioScience 35(4):239-243.
- Pierce, B.M. and V.C. Bleich. 2003. Mountain lion (*Puma concolor*). Pages 744-757 in G.A. Feldhamer, B.C. Thompson, and J.A. Chapman, editors. Wild mammals of North America: biology, management, and conservation. The Johns Hopkins University Press, Baltimore, MD.
- Pokras, M.A., C. Hanley, and Z. Gordon. 1998. Liver mercury and methylmercury concentrations in New England common loons (*Gavia immer*). Env. Tox. and Chem. 17(2):202-204.
- Pope, C.H. 1967. Turtles of the United States and Canada. Alfred A. Knopf. New York.
- Porter, R.D., and C.M. White. 1973. The peregrine falcon in Utah, emphasizing ecology and competition with the prairie falcon. Brigham Young Univ. Sci Bull., Biol. Ser. 18(1):1-74.
- Randall, A.D. 1996. Mean Annual Runoff, Precipitation, and Evapotranspiration in the Glaciated Northeastern United States, 1951-80. USGS Open-File Report 96-395. Available at: <http://ny.water.usgs.gov/pubs/of/of96395/OF96-395.html>
- Richards, T. 1994. Bicknell's thrush. Pages 218-219 in C.R. Foss, editor. The atlas of breeding birds of New Hampshire. Audubon Society of New Hampshire, Concord, New Hampshire.
- Richards, T. and K.C. Elkins. 1994. Common Loon *Gavia immer*. Pages 2-3. in C.R. Foss, editor. The atlas of breeding birds of New Hampshire. Audubon Society of New Hampshire, Concord, NH.
- Rimmer, C. 1992. Common loon *Gavia immer*. Migratory nongame birds of management concern in the Northeast. USDI FWS, Newton Corner, MA.
- Rimmer, C.C., J.A. Atwood, K.P. McFarland, and L.R. Nagy. 1996. Population density, vocal behavior, and recommended survey methods for Bicknell's thrush. Wilson Bulletin 108:639-649.
- Rimmer, C.C., K.P. McFarland, and J.E. Goetz. 1999. Demographics and ecology of Bicknell's thrush and montane forest birds in the Dominican Republic. Unpublished report. Vermont Institute of Natural Science, Woodstock, Vermont.
- Rimmer, C.C., K.P. McFarland, W.G. Ellison, and J.E. Goetz. 2001a. Bicknell's thrush (*Catharus bicknelli*). In A. Poole and F. Gill, editors. Birds of North America, No. 592. The Birds of North America, Inc., Philadelphia, PA.
- Rimmer, C.C., K.P. McFarland, and J.D. Lambert. 2001b. Bicknell's thrush (*Catharus bicknelli*) conservation assessment. GMNF, Rutland, VT.
- Rimmer, C.C. and S.D. Faccio. 2004. Ecology and demography of Bicknell's Thrush on East Mountain, East Haven, Vermont: evaluating potential impacts of wind turbine construction. Unpublished report to Vermont Fish and Wildlife Department, Vermont Institute of Natural Science, Woodstock, VT.
- Rimmer, C.C., K.P. McFarland, J.D. Lambert, and R.B. Renfrew. 2004. Evaluating the use of Vermont ski areas by Bicknell's Thrush – applications for Whiteface Mountain, New York. Unpublished report to the Olympic Regional Development Authority, Vermont Institute of Natural Science, Woodstock, VT.
- Rimmer, C.C., J.M. Townsend, A.K. Townsend, E.M. Fernández, and J. Almonte. 2005a. Avian diversity, abundance, and conservation status in the Macaya Biosphere Reserve of Haiti. Ornithología Neotropical. 16:219-230.
- Rimmer, C.C., K.P. McFarland, D.C. Evers, E.K. Miller, Y. Aubry, D. Busby, and R.J. Taylor. 2005b. Mercury levels in Bicknell's Thrush and other insectivorous passerine birds in montane forests of northeastern North America. Ecotoxicology 14:223-240.
- Rimmer, C.C., J.D. Lambert, and K.P. McFarland. 2005c. Bicknell's Thrush (*Catharus bicknelli*) conservation strategy for the Green Mountain National Forest. Unpublished report to the Green Mountain National Forest. Vermont Institute of Natural Science, Woodstock, VT.
- Robbins, L.W., M.D. Engstrom, R.B. Wilhelm, and J.R. Choate. 1977. Ecogeographic status of *Myotis leibii* in Kansas. Mammalia 41:365-367.
- Romito, J.P. 2004. Mineral report for Forest Plan revision. U.S. Department of the Interior, Bureau of Land Management, Rolla, Missouri. 6pp.



- Rommé, R.C., K. Tyrell, and V. Brack Jr. 1995. Literature summary and habitat suitability index model, components of summer habitat for the Indiana bat (*Myotis sodalis*). Federal Aid Project E-1-7, Study No. 8. Report submitted to Indiana Department of Natural Resources, Bloomington, IN.
- Rompré, G., Y. Aubry, and A. Kirkconnell. 2000. Recent observations of threatened birds in Cuba. *Cotinga* 13:66.
- Rosenberg, K.V., and J.V. Wells. 1995. Importance of geographic area to Neotropical migrant birds in the Northeast. Unpubl. rep. U.S. Fish and Wildlife Service, Hadley, MA.
- Ross, D.A., Brewster, K.N., Anderson, R.K., Ratner, N. and C.M. Brewster. 1991. Aspects of the ecology of wood turtles, *Clemmys insculpta*, in Wisconsin. *The Canadian Field-Naturalist* 105:363-367.
- Rowe, C.L. and W.A. Dunson. 1993. Relationships among abiotic parameters and breeding effort by three amphibians in temporary wetlands of central Pennsylvania. *Wetlands* 13(4):237-246.
- Rowe, C.L., W.J. Sadinski, and W.A. Dunson. 1992. Effects of acute and chronic acidification on three larval amphibians that breed in temporary pools. *Archives of Environmental Contamination and Toxicology* 23:339-350.
- Ruggiero, L.F., K.B. Aubry, S.W. Buskirk, G.M. Koehler, C.J. Krebs, K.S. McKelvey, and J.R. Squires. 1999. Ecology and conservation of lynx in the United States. USDA Forest Service, Rocky Mountain Research Station General Technical Report RMRS-GTR-30WWW. 480pp.
- Russell, K.R. 1978. Mountain Lion. Pages 207-225 in J.L. Schmidt and D.L. Gilbert, editors. *Big game of North America ecology and management*. Stackpole, Harrisburg, Pennsylvania.
- Sadinski, W.J. and W.A. Dunson. 1992. A multilevel study of effects of low pH on amphibians of temporary ponds. *Journal of Herpetology* 26(4):413-421.
- SaintOurs, F. 2002. Aquatic Macro Invertebrates fauna in streams of eastern Massachusetts and their use as water quality indicators. Thesis information from website, University of Massachusetts, Boston, MA, accessed 22 March 22 2002: <http://omega.cc.umb.edu/~conne/fred/thesis/orgs.htm>.
- Sams, C. 2002. Green Mountain & Finger Lakes air quality assessment package. USDA Forest Service, Region 9 Air Program. Milwaukee, Wisconsin.
- Sanders, C, S.R. Darling, C. Grove, S. von Oettingen, and S. Parren. *In preparation*. Vermont Multi-Species Bat Conservation and Recovery Plan. Sanders Environmental, Inc., and the Vermont Bat Conservation and Recovery Plan Team. Nongame and Natural Heritage Program, Vermont Fish and Wildlife Department, Waterbury, Vermont.
- Sankey, J.A. 1999. Guide to Adult Damselflies and Dragonflies of the Ottawa District. Website accessed 28 October 2004: <http://www.sankey.ws/odon2.html>.
- Semlitsch, R.D. 1981. Terrestrial activity and summer home range of the mole salamander (*Ambystoma talpoideum*). *Canadian Journal of Zoology* 59:315-322.
- Semlitsch, R.D. 1998. Biological delineation of terrestrial buffer zones for pond-breeding salamanders. *Conservation Biology* 12:1113-1119.
- Sheen, D.A. and J.P. Gibbs. 2004. Effects of roads on the structure of freshwater turtle populations. *Conservation Biology* 18(4):1143-1149.
- Skaggs, R.W., D.H. Ellis, W.G. Hunt, and T.H. Johnson. 1988. Peregrine falcon. Pages 127-136 in Glinski, R.L., B.G. Pendleton, M.B. Moss, M.N. LeFranc Jr., B.A. Millsap, and S.W. Hoffman. 1988. Proceedings of the Southwest raptor management symposium and workshop, 21-24 May 1986, University of Arizona, Tucson. National Wildlife Federation Scientific and Technical Series No.11. National Wildlife Federation, Washington, D.C.
- Spolsky, C., C.A. Phillips, and T. Uzzell. 1992. Gynogenetic reproduction in hybrid mole salamanders (genus *Ambystoma*). *Evolution* 46(6):1935-1944.
- Stalmaster, M.V. and J.L. Kaiser. 1998. Effects of recreational activity on wintering bald eagles. *Wildlife Monographs* No. 137. Supplement to the *Journal of Wildlife Management* 62(2):1-46.
- Strang, C.A. 1983. Spatial and temporal activity patterns in two terrestrial turtles. *Journal of Herpetology* 17(1):43-47.
- Strong, P.I.V. 1985. Habitat selection by common loons. Ph.D. Thesis. University of Maine, Orono.
- SVE (Species Viability Evaluation) Alpine Plants Panel. 2002. Green Mountain and White Mountain National Forests species viability evaluation expert panel notes on alpine plants. Panel held: May 13-15, 2002, Rutland, Vermont, USA.

- SVE (Species Viability Evaluation) Aquatic Plants Panel. 2002. Green Mountain and White Mountain National Forests species viability evaluation expert panel notes on aquatic species. Panel held: May 15-16, 2002, Rutland, Vermont, USA.
- SVE (Species Viability Evaluation) Bird Panel. 2002. Green Mountain and White Mountain National Forests species viability evaluation expert panel notes on birds. Panel convened May 21-22, 2002, Manchester, NH.
- SVE (Species Viability Evaluation) Forested Wetland Plants Panel. 2002. Green Mountain and White Mountain National Forests species viability evaluation expert panel notes on forested wetland plants. Panel held May 13-14, 2002, Rutland, Vermont, USA.
- SVE (Species Viability Evaluation) Herpetology Panel. 2002. Green Mountain and White Mountain National Forests species viability evaluation expert panel notes on amphibian and reptile Species. Panel convened June 25, 2002, Manchester, New Hampshire.
- SVE (Species Viability Evaluation) Insect Panel. 2002. Green Mountain and White Mountain National Forests species viability evaluation expert notes on insects: lepidopterans, odonates, and beetles. Panel corresponded via email, FAX, and telephone.
- SVE (Species Viability Evaluation) Invertebrate Panel. 2002. Green Mountain National Forest and White Mountain National Forest species viability evaluation expert panel notes on the brook floater (*Alasmodonta varicose*). Panel held July 29, 2002.
- SVE (Species Viability Evaluation) Mammal Panel. 2002. Green Mountain and White Mountain National Forests species viability evaluation expert panel notes on mammals. Panel convened May 21-23, 2002, Manchester, NH.
- SVE (Species Viability Evaluation) Mammal Panel. 2003. Finger Lakes National Forest species viability evaluation expert panel notes on mammals. Panel convened August 14, 2003, Ithaca, New York.
- SVE (Species Viability Evaluation) Oak-Pine Plants Panel. 2002. Green Mountain and White Mountain National Forests species viability evaluation expert panel notes on oak-pine plants. Panel held June 5-6, 2002, Rutland, Vermont, USA.
- SVE (Species Viability Evaluation) Open Rocks Plants Panel. 2002. Green Mountain and White Mountain National Forests species viability evaluation expert panel notes on open rocks and fields. Panel held June 3-4, 2002, Concord, New Hampshire, USA.
- SVE (Species Viability Evaluation) Open/Nonforested Wetland Plants Panel. 2002. Green Mountain and White Mountain National Forests species viability evaluation expert panel notes on open/nonforested wetland plants. Panel held May 13, 2002, Rutland, Vermont, USA.
- SVE (Species Viability Evaluation) Upland Forest Plants Panel. 2002. Green Mountain and White Mountain National Forests species viability evaluation expert panel notes on upland forests. Panel held June 3-4, 2002, Concord, New Hampshire, USA.
- Taylor, J. 1993. The amphibians and reptiles of New Hampshire. Nongame and Endangered Wildlife Program, New Hampshire Fish and Game Department, Concord, NH. 71 pp.
- Tetra Tech. 2003. Green Mountain National Forest Soil Assessment. U.S. Department of Agriculture, Forest Service, unpublished report.
- Theberge, J.B., Theberge, M.T., and Forbes, G. 1996. What Algonquin Park wolf research has to instruct about recovery in northeastern United States. *In* Proceedings Defenders of Wildlife's Wolves of America Conference, 14-16 November 1996, Albany, New York.
- Thomas, D.W. 1995. Hibernating bats are sensitive to nontactile human disturbance. *Journal of Mammalogy* 76:940-946.
- Thomas, D.W., M. Dorais, and J.M. Bergeron. 1990. Winter energy budgets and cost of arousals for hibernating little brown bats, *Myotis lucifugus*. *Journal of Mammalogy* 71:475-479.
- Thompson, E.L., Gates, J.E., and G.J. Taylor. 1980. Distribution and breeding habitat selection of the Jefferson salamander, *Ambystoma jeffersonianum*, in Maryland. *Journal of Herpetology* 14:113-120.
- Thompson, E.H. 2002. Vermont's natural heritage: conserving biodiversity in the Green Mountain State. A report from the Vermont Biodiversity Project. Available from The Nature Conservancy, Montpelier, Vermont. Also available at: <http://www.uvm.edu/~envnr/sal/vbp/VBP.pdf>.
- Thompson, E.H. and E.R. Sorenson. 2000. Wetland, woodland, wildland: a guide to the natural communities of Vermont. University Press of New England, Hanover, New Hampshire.
- Thomson, C.E. 1982. Mammalian species, *Myotis sodalis*. *American Society of Mammalogists* 163:1-5.

- Todd, C.S., L.S. Young, R.B. Owen, Jr., and F.J. Gramlich. 1982. Food habits of bald eagles in Maine. *Journal of Wildlife Management* 46(3):636-645.
- Torsello, M. and Allen, K.A. 1994. Trip report: butternut status on the Green Mountain National Forest, Middlebury, Vermont, USA.
- Trombulak, S.C. and K. Royar. 2000. Restoring the wild: species recovery and reintroduction. In C.M. Klyza, editor. *Wilderness comes home: rewilding the Northeast*. University Press of New England. Hanover, NH.
- Tumlinson, R. 1987. Mammalian species, *Felis lynx*. *The American Society of Mammalogists* 269:1-8.
- Tuttle, M.D. 1964. *Myotis subulatus* in Tennessee. *Journal of Mammalogy* 45:148-149.
- Tuttle, S.E., and D.M. Carroll. 1997. Ecology and natural history of the wood turtle (*Clemmys insculpta*) in southern New Hampshire. *Chelonian Conservation and Biology* 2(3):447-449.
- USDA (USDA Forest Service). 1999. Biological assessment for threatened and endangered species on the Green Mountain National Forest Vermont: August 27, 1999.
- USDA (USDA Forest Service). 2001. Environmental assessment for the proposed amendment to the Green Mountain National Forest Land and resource management plan for threatened, endangered, and sensitive species, January 2001. Green Mountain National Forest, Rutland, Vermont. 74 pp.
- USDA (United States Department of Agriculture, Forest Service). 2002a. Implementing the Green Mountain National Forest land and resource management plan – a fifteen-year retrospective. Green Mountain National Forest, Rutland, Vermont.
- USDA (USDA Forest Service). 2002b. Land and Resource Management Plan, Green Mountain National Forest, Amendment No. 9, April 2002. Green Mountain National Forest, Rutland, VT.
- USDA (USDA Forest Service). 2004. Green Mountain National Forest Species Viability Evaluation Process and Plants of Viability Concern. Green Mountain National Forest, Rutland, VT.
- USFS (U.S. Forest Service). 2002a. Species literature review form for *Canis lupus*, gray wolf. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.
- USFS (U.S. Forest Service). 2002b. Species literature review form for *Puma concolor cougar*, eastern cougar. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.
- USFS (U.S. Forest Service). 2002c. Species literature review form for *Lynx canadensis*, Canada lynx. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.
- USFS (U.S. Forest Service). 2002d. Species literature review form for *Myotis sodalis*, Indiana bat. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.
- USFS (U.S. Forest Service). 2002e. Species literature review form for *Haliaeetus leucocephalus*, bald eagle. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.
- USFS (U.S. Forest Service). 2002f. Species literature review form for *Myotis leibii*, eastern small-footed bat. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.
- USFS (U.S. Forest Service). 2002g. Species literature review form for *Catharus bicknelli*, Bicknell's thrush. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.
- USFS (U.S. Forest Service). 2002h. Species literature review form for *Falco peregrinus anatum*, American peregrine falcon. USDA Forest Service, Green Mountain National Forest, Rutland, VT.
- USFS (U.S. Forest Service). 2002i. Species literature review form for *Gavia immer*, common loon. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.
- USFS (U.S. Forest Service). 2002j. Species literature review form for *Clemmys insculpta*, wood turtle. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.
- USFS (U.S. Forest Service). 2002k. Species literature review form for *Ambystoma jeffersonianum*, Jefferson salamander. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.
- USFS (U.S. Forest Service). 2002l. Species literature review form for *Cicindela ancocisconensis*, boulder beach tiger beetle. USDA Forest Service, Green Mountain National Forest, Rutland, VT.
- USFS (U.S. Forest Service). 2002m. Species literature review form for southern pygmy clubtail, *Lanthus vernalis*. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.
- USFS (U.S. Forest Service). 2002n. Species literature review form for *Somatochlora forcipata*, forcipate emerald. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.
- USFS (U.S. Forest Service). 2002o. Species literature review form for *Gomphus desertus*, harpoon clubtail. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.
- USFS (U.S. Forest Service). 2002p. Species literature review form for *Tachopteryx thoreyi*, gray petaltail. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.

- USFS (U.S. Forest Service). 2002q. Species literature review form for *Alasmidonta varicosa*, brook floater. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.
- USFS (U.S. Forest Service). 2002r. Species literature review form for *Lasmigona compressa*, creek heelsplitter. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.
- USFS (U.S. Forest Service). 2003. Threatened, endangered, and sensitive species lists. Region 9, Milwaukee, Wisconsin. Available at: [http://www.fs.fed.us/r9/wildlife/tes/tes\\_lists.htm](http://www.fs.fed.us/r9/wildlife/tes/tes_lists.htm).
- USFWS (U.S. Fish and Wildlife Service). 1982. Eastern cougar recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia.
- USFWS (U.S. Fish and Wildlife Service). 1983. Recovery plan for the Indiana bat. U.S. Fish and Wildlife Service, Twin Cities, Minnesota. 82 pp. (in Cooperation with the Indiana Bat Recovery Team).
- USFWS (U.S. Fish and Wildlife Service). 1990. Endangered and threatened species recovery program: report to Congress. 406 pp. In [natureserve.org](http://natureserve.org).
- USFWS (U.S. Fish and Wildlife Service). 1991. Updated peregrine falcon eastern population recovery plan. USFWS, Newton Corner, MA.
- USFWS (U.S. Fish and Wildlife Service). 1992. Recovery plan for the eastern timber wolf. Twin Cities, Minnesota. 73 pp.
- USFWS (U.S. Fish and Wildlife Service). 1999. Agency draft Indiana bat (*Myotis sodalis*) revised recovery plan. Prepared by the Indiana Bat Recovery Team for the U.S. Fish and Wildlife Service, Ft. Snelling, Minnesota. 53 pp.
- USFWS (U.S. Fish and Wildlife Service). 2000a. Letter of consultation on the continued implementation of the Land and Resource Management Plan (LRMP), as amended, and the projects predicated on it. From Michael J. Bartlett, Supervisor, New England Field Office, U.S. Fish and Wildlife Service, 22 Bridge Street, Unit #1, Concord, New Hampshire, to Robert T. Jacobs, Regional Forester, Eastern Region, USDA Forest Service, 310 West Wisconsin Avenue, Suite 580, Milwaukee, WI 53203. February 16, 2000.
- USFWS (U.S. Fish and Wildlife Service). 2000b. Biological opinion on the effects of the land and resource forest management plan and other activities on the threatened and endangered species in the Green Mountain National Forest and incidental take statement. U.S. Fish and Wildlife Service, New England Field Office, 22 Bridge Street, Concord, New Hampshire. 41 pp.
- USFWS (U.S. Fish and Wildlife Service). 2004. Letter of consultation on the revision of the Land and Resource Management Plan (LRMP), for the Green Mountain National Forest. From Michael J. Amaral, Endangered Species Specialist, U.S. Fish and Wildlife Service, New England Field Office, 70 Commercial Street, Suite 300, Concord, New Hampshire 03301-5087, to Paul Brewster, Forest Supervisor, Green Mountain National Forest. September 16, 2004.
- USFWS (U.S. Fish and Wildlife Service). 2006. Letter of consultation on the revision of the Land and Resource Management Plan (LRMP), for the Green Mountain National Forest. From Michael J. Amaral, Endangered Species Specialist, U.S. Fish and Wildlife Service, New England Field Office, 70 Commercial Street, Suite 300, Concord, New Hampshire 03301-5087, to Paul Brewster, Forest Supervisor, Green Mountain National Forest. January 23, 2006.
- VFWD (Vermont Fish and Wildlife Department). 2005a. Vermont's comprehensive wildlife conservation strategy: September 7, 2005. Vermont Fish and Wildlife Department, Waterbury, Vermont. Available online at [www.vtfishandwildlife.com](http://www.vtfishandwildlife.com).
- VFWD (Vermont Fish and Wildlife Department). 2005b. Peregrine, osprey and loon are delisted. Press release from the Vermont Fish and Wildlife Department, Waterbury, Vermont, 19 May 2005.
- VNNHP (Vermont Nongame and Natural Heritage Program). 2000. Rare and uncommon native animals of Vermont. Nongame and Natural Heritage Program, Vermont Fish and Wildlife Department. Website accessed 2 September 2004:  
[http://www.vtfishandwildlife.com/library/Reports\\_and\\_documents/nongame\\_and\\_Natural\\_Heritage/Rare\\_Threatened\\_and\\_Endangered\\_Species/Endangered\\_and\\_Threatened\\_Animals\\_of\\_Vermont-March\\_2002.pdf](http://www.vtfishandwildlife.com/library/Reports_and_documents/nongame_and_Natural_Heritage/Rare_Threatened_and_Endangered_Species/Endangered_and_Threatened_Animals_of_Vermont-March_2002.pdf).
- VNNHP (Vermont Nongame and Natural Heritage Program). 2002. Endangered and threatened plants of Vermont. Vermont Department of Fish and Wildlife, Nongame and Natural Heritage Program. March 2002. Website accessed 28 September 2004:  
[http://www.vtfishandwildlife.com/library/Reports\\_and\\_documents/nongame\\_and\\_Natural\\_Heritage](http://www.vtfishandwildlife.com/library/Reports_and_documents/nongame_and_Natural_Heritage)

- tage/Rare\_Threatened\_and\_Endangered\_Species/Endangered%20and\_Threatened\_Plants\_of\_Vermont-March\_2002.pdf.***
- VNNHP (Vermont Nongame and Natural Heritage Program). 2003. Natural heritage news. Natural Heritage Harmonies, Summer 2003:1-6.
- VNNHP (Vermont Nongame and Natural Heritage Program). 2004. Vermont's wildlife heritage, species at risk: wood turtle *Clemmys insculcata*. Vermont Agency of Natural Resources, Department of Fish and Wildlife. Website accessed 10 October 2004:  
***[http://www.vtfishandwildlife.com/library/Factsheets/NonGame\\_and\\_Natural\\_Heritage/Wood\\_Turtle\\_factsheet.pdf](http://www.vtfishandwildlife.com/library/Factsheets/NonGame_and_Natural_Heritage/Wood_Turtle_factsheet.pdf)***
- Vogelmann, J.E. 1995. Assessment of forest fragmentation in southern New England using remote sensing and geographic information systems technology. *Conservation Biology* 9:439-449.
- VRAA (Vermont Reptile and Amphibian Atlas). 2004. Vermont reptile and amphibian atlas website. Jim Andrew, Biology Department, Middlebury College, Middlebury, Vermont. Website accessed 25 October 2004: ***<http://www.middlebury.edu/herpatlas>***.
- Wallace, G.J. 1939. Bicknell's thrush, its taxonomy, distribution, and life history. *Proc. Boston Soc. Nat. Hist.* 41:211-402.
- Waltz, R.D. 1998. Gleaning on Coreidae by *Tachopteryx thoreyi*. *The Great Lakes Entomologist*. p. 209
- WDA (Worldwide Dragonfly Association). 2004. A beginner's guide to dragonflies.***[http://people.colgate.edu/wda/Beginners\\_Guide.htm](http://people.colgate.edu/wda/Beginners_Guide.htm)***, accessed 28 October 2002.
- Watrous, K.S. T.M. Donovan, R.M. Mickey, S.R. Darling, A.C. Hicks, and S.L. vonOettingen. In Press. Predicting minimum habitat characteristics of the Indiana bat in the Champlain Valley. *Journal of Wildlife Management* xx:xx-xx.
- Webb, O.L. and J.K. Jones, Jr. 1952. An annotated checklist of Nebraskan bats. University of Kansas Publications, Museum of Natural History 5:269-279.
- Webster, W.D., J.F. Parnell, and W.C. Briggs, Jr. 1985. Mammals of the Carolinas, Virginia, and Maryland. University of North Carolina Press, Chapel Hill, NC. 255 pp.
- Wetmore, A., and B.H. Swales. 1931. The birds of Haiti and the Dominican Republic. *Bull. Mus. Comp. Zool.* 63:340-341.
- Wharton, E.H., R.H. Widmann, C.H. Barnett, T.S. Frieswyk, A.J. Lister, and B. DeGeus. 2003. The forests of the Green Mountain State. Resource Bulletin NE-158. U.S. Department of Agriculture, Forest Service, Northeastern Research Station, Newtown Square, PA. 25 pp.
- Whitaker, J.O., Jr., and W.J. Hamilton, Jr. 1999. Mammals of the eastern United States. Comstock Publishing Associates. Ithaca, NY. Pp. 89-92.
- Wiemeyer, S.N., C.M. Bunck, and C.J. Stafford. 1993. Environmental contaminants in bald eagle eggs – 1980-84 – and further interpretations of relationships to productivity and shell thickness. *Arch. Environ. Contam. Toxicol.* 24:213-227.
- Williams, K.J., R. Mies, and A. Kurta. 1993. Roost site selection of the Indiana bat *Myotis sodalis* on the northern edge of its range. *Bat Research News*, Winter 1993. 153 pp.
- Williams, P. 1996. A classification of the wetlands of the Green Mountain National Forest and classification results for 1995 field work. USDA Forest Service, Green Mountain National Forest, Rutland, Vermont.
- Wilson, D.A. and A.E. Brower. 1983. The Cicindelidae of Maine. *Cicindela* 15:1-33.
- Wilson, D.A. and A. LaRochelle. 1979. *Cicindela ancociscoensis* T.W. Harris. *Cicindela* 11:33-48.
- Wilson, P.J., S. Grewel, I.D. Lawford, J.N.M. Heal, A.G. Granacki, D. Pennock, J.B. Theberge, M.T. Theberge, D.R. Voigt, W. Waddell, R.E. Chambers, P.C. Paquet, G. Goulet, D. Cluff, and B. White. 2000. DNA profiles of the eastern Canadian wolf and the red wolf provide evidence for a common evolutionary history independent of the gray wolf. *Canadian Journal of Zoology* 78:2156-2166.

#### Personal Communications

- James S. Andrews, Middlebury College, Middlebury, Vermont. Personal communication to Diane Burbank and John Sease, GMNF, July 2005.
- Paul M. Brunelle, Personal communication to Diane Burbank and John Sease, GMNF, May 2005.
- Scott Darling, Vermont Fish and Wildlife Department, Rutland, Vermont. Personal communication to John Sease, GMNF, June 2004.

Scott Darling, Vermont Fish and Wildlife Department, Rutland, Vermont. Personal communication to Diane Burbank and John Sease, GMNF, May 2005.

Steven D. Faccio, Vermont Institute of Natural Science, Woodstock, Vermont. Personal communication to Diane Burbank and John Sease, GMNF, May 2005.

Allison Reger, USDA Forest Service, Willamette National Forest, Eugene, Oregon. Personal communication to John Sease, GMNF, January 2005.

Mariko Yamasaki, USDA Forest Service Northeastern Research Station, Durham, New Hampshire, Personal communication *cited in* USDA (1999).